MYCOLOGIA

VOL. VI JULY, 1914 No. 4

ILLUSTRATIONS OF FUNGI—XVIII

WILLIAM A. MURRILL

The accompanying plates were made from specimens collected in the vicinity of New York City or in adjoining states within easy reach. The species selected are of such a character as to be well represented without the use of color. Several of them are of importance to the mycophagist.

Lycoperdon Bovista L.

Lycoperdon giganteum Batsch

GIANT PUFFBALL

Plate 126. × 1/8

Peridium very large, globose or depressed-globose, sessile or nearly so, 20–35 cm. or more in diameter; surface glabrous or slightly flocculose, white, whitish, or slightly yellowish, becoming dingy with age; spores globose, greenish-yellow becoming dingy-olivaceous, 4 μ; capillitium greenish-yellow becoming dingy-olivaceous.

The giant puffball, easily recognized by its large size and smooth white appearance, occurs infrequently in fields, pastures, or woods throughout most of the United States, as well as in parts of Europe and Asia. The specimens here figured grew in Mrs. Boeder's yard in Williamsbridge, New York City, and were photographed by her. The species has also been collected at least twice in the hemlock grove in the New York Botanical Garden. Authentic records have been made of specimens three feet in diameter, but they rarely become much larger than a man's head. The flavor of

[MYCOLOGIA for May, 1914 (6: 103–159), was issued May 30, 1914]

this species is particularly good, and little cooking is required. The writer remembers coming suddenly some years ago upon four large giant puffballs grouped picturesquely about an old stump in a beech grove near Ithaca, New York, and the pleasure he had, not only in gazing at them, but in getting them home and distributing them in quarter sections to a number of his friends.

Lycoperdon pyriforme Schaeff.

PEAR-SHAPED PUFFBALL

Plate 127. × 1

Peridium pear-shaped, 2.5–5 × 2–3 cm., dingy-white or brownish, with white, branching mycelium; cortex of thin, minute, often persistent scales or granules, or of short, stout spinules; inner peridium smooth, very thin, concolorous, opening apically; subgleba small, white, rather compact, of minute cells; spores globose, smooth, greenish-yellow to brownish-olive, 3.5–4 μ; capillitium of long, branched threads, which form a dense tuft in the center, columella present.

This species occurs very commonly in dense clusters on decayed wood or humus throughout most of the United States and Canada, as well as in Europe and Asia. As a rule, the smaller puffballs are poorly flavored and this one is particularly so; but it may be used when everything else is scarce. I have often eaten quite young specimens of this species late in the fall, flavoring them with bacon, parsley, onion, butter, salt, and pepper, and adding, if convenient, a few sporophores of the common mushroom.

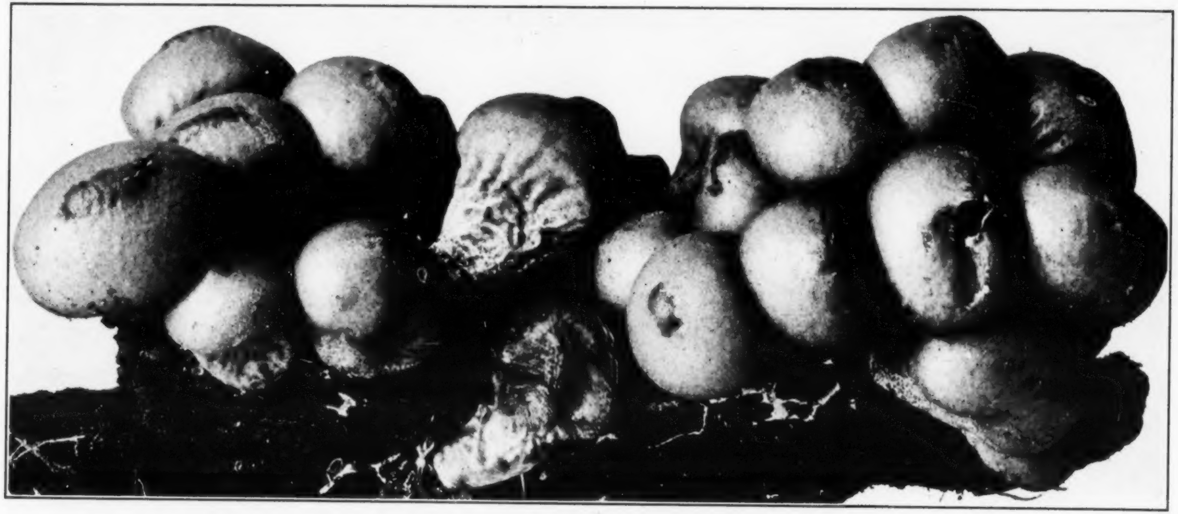
Sparassis Herbstii Peck

HERBST'S SPARASSIS

Plate 128. × 1

Sporophore much branched, whitish inclining to creamy-yellow, 10–12.5 cm. high and 12.5–15 cm. broad; branches numerous, thin, tough, moist, flattened, concrescent, dilated above and spatulate or fan-shaped, often somewhat longitudinally curved or wavy, mostly uniformly colored, rarely with a few indistinct, nearly concolorous, transverse zones near the broad entire apices; spores subglobose or broadly ellipsoid, 5–6.2 × 4–5 μ.

This species was originally described from specimens collected by Herbst at Trexlertown, Pa. The accompanying photograph is



LYCOPERDON PYRIFORME SCHÆFF.

from plants collected in wood's near New Rochelle, New York, by Miss Daisy Levy. This species is closely related to *Sparassis crispa,* which is often seen in European markets. It is edible, but unfortunately too rare to be of economic importance.

Asterophora Clavus (Schaeff.) Murrill

Nyctalis asterophora Fries

CLUB-SHAPED ASTEROPHORA

Plate 129. × 1

Pileus hemispheric to depressed, usually distorted, gregarious, 1–2.5 cm. broad; surface white to fawn-colored or brownish, floccose, spongy, usually powdered with the brownish chlamydospores; margin involute, thick; context thick, fleshy, grayish-white, of farinaceous taste and odor; lamellae thick, dull-grayish, distant, adnate, usually undeveloped; spores not seen; chlamydospores large, stellate, brownish, 15–20 μ; stipe pruinose, white to brownish, stuffed or hollow, brown within, 1.5–2.5 cm. long, 3–8 mm. thick.

This tiny and peculiar parasitic agaric occurs on decaying sporophores of *Russula, Lactaria, Chanterel, Clitocybe,* and other large species of gill-fungi throughout Europe and the eastern United States. The sporophores are usually partly decayed and blackened before the parasite comes to maturity. The gills are fold-like as in *Chanterel,* and the surface of the pileus often bears large star-shaped conidia, which give it a powdery appearance.

Collybia maculata (Alb. & Schw.) Quél.

SPOTTED COLLYBIA

Plate 130. × 1

Pileus fleshy, firm, convex or nearly plane, 5–10 cm. broad; surface even, glabrous, white or whitish, often variegated with reddish spots or stains; context white; lamellae narrow, crowded, adnexed, sometimes nearly or quite free, white or whitish; spores subglobose, at times slightly apiculate at one end, 4–6 μ; stipe firm, striate, white, usually stout, equal or subequal, often curved below, commonly attenuate and radicate at the base, 5–10 cm. long, 6–12 mm. thick.

This species is one of the largest of the genus and occurs in humus or on much decayed wood in woods throughout the greater

part of the eastern United States, as well as in Europe. The surface is usually decorated with reddish spots or stains, but varieties occur in which these spots are entirely absent.

Hygrophorus eburneus (Bull.) Fries

IVORY HYGROPHORUS

Plate 131. × ⅔

Pileus fleshy, moderately thick, sometimes thin, convex to expanded, 3–8 cm. broad; surface very viscid or glutinous, completely covered with a coating of gluten, entirely white; context having a mild and not unpleasant odor; lamellae strongly decurrent, distant, with vein-like elevations near the stipe; spores ovoid, granular 6–10 × 5–6 μ; stipe spongy to stuffed within, sometimes hollow and tapering below, 6–15 cm. long, 3–8 mm. thick.

This attractive edible species is widely distributed throughout the cooler regions of Europe and America, occurring on the ground in woods or in partially shaded places. The writer found it to be one of the most common and abundant species on the Pacific coast. In many localities, a basketful could have been gathered in a very small area. Its white color, slimy covering, mild odor, and decurrent, distant gills will serve to distinguish it from closely related species.

Lactaria piperata (L.) Pers.

PEPPERY LACTARIA

Plate 132. Lower Figure. × ½

Pileus fleshy, convex-umbilicate, at length infundibuliform, 4–12 cm. or more in diameter; surface white, azonate, dry, glabrous; margin involute at first and naked, at length uplifted; context compact, white, unchanging or becoming sordid, edible; latex white, unchanging, very acrid, abundant; lamellae white or creamy-white, forking dichotomously, close, more or less decurrent, arcuate at first, then extending upwards, only about 2 mm. broad; spores white, subglobose, nearly smooth, 8–9 μ in diameter; stipe white, equal, dry, often pruinose, solid and firm, 2–8 cm. long, up to 2 cm. thick.

Found in great abundance in oak woods throughout temperate North America, as well as in Europe. It contains an acid and a resin, "piperon," which is extremely acrid in the fresh state, but

SPARASSIS HERBSTII PECK

is disorganized by heat. This species is therefore harmless when cooked, but is coarse and poorly flavored. If eaten, it must be carefully distinguished from poisonous species that are acrid in the fresh state.

Lepiota naucina (Fries) Quél.

SMOOTH LEPIOTA

Plate 133. × 1

Pileus thick, globose to convex, 5–8 cm. broad; surface dry, usually white and smooth, at times slightly yellowish or granular on the disk; context firm, fleshy, white, mild; lamellae free, white, dull-pinkish with age; spores usually white in mass, rarely tinged with pink; stipe white, smooth, enlarged below, bearing a white annulus above, 6–10 cm. long, 8–16 mm. thick.

This excellent and widely distributed temperate species occurs in the autumn in lawns and pastures where the common mushroom grows and is often picked and thrown away because the lamellae are white. There is no harm in using it for food if the collector and those who may imitate him distinguish it carefully from the white variety of *Venenarius phalloides,* which is so common in this region and has been the cause of most of the deaths among mushroom eaters in the vicinity of New York City. It must be remembered that this deadly species is picked by some persons for the common mushroom, in spite of its white lamellae and bulbous stipe. How much more easily might *Lepiota naucina,* which has both characters, be confused with it! The deadly *Amanita phalloides* may be distinguished from *Lepiota naucina* by the "death-cup" at the base of the stipe, by the longer and usually more bulbous stipe, and by the gills remaining white instead of becoming slightly dull-pinkish with age.

Agaricus campester hortensis Cooke

GARDEN MUSHROOM

Plate 134. × ⅔

This variety of the common mushroom has been found in great abundance in an old pile of cow manure east of Bronx Park, partly shaded by weeds. It differs from the form usually found in pastures which was described and figured in MYCOLOGIA for March, 1909, chiefly in its slightly larger size, darker color, and more con-

spicuous scaly covering. This variety is often cultivated but is rarely found wild.

Psathyrella disseminata (Pers.) Quél.

SCATTERED PSATHYRELLA

Plate 132. Upper Figure. × 1

Pileus membranaceous, ovoid-campanulate, densely gregarious or cespitose, 6–10 mm. broad; surface minutely scaly becoming smooth, whitish, gray, or grayish-brown; margin sulcate-plicate, entire; lamellae adnate, broad, white to gray, then black; spores ellipsoid, $8 \times 6 \mu$; stipe furfuraceous to glabrous, yellowish to cinereous, very slender becoming hollow, often curved, about 2.5 cm. long and 1 mm. thick.

This small and very beautiful species is widely distributed in Europe and America on decayed wood and moist earth containing organic matter, the caps occuring in such large numbers in one spot that it is entirely impossible to count them. It may be looked for throughout the season from early summer until late autumn and it often appears on the soil in greenhouses during the winter. The species strongly suggests *Coprinus,* both in its mode of expanding and in blackening with age, when the black spores are mature.

NEW YORK BOTANICAL GARDEN.

ASTEROPHORA CLAVUS (SCHÆFF.) MURRILL

A CONSIDERATION OF THE PROPERTIES OF POISONOUS FUNGI

William W. Ford and Ernest D. Clark

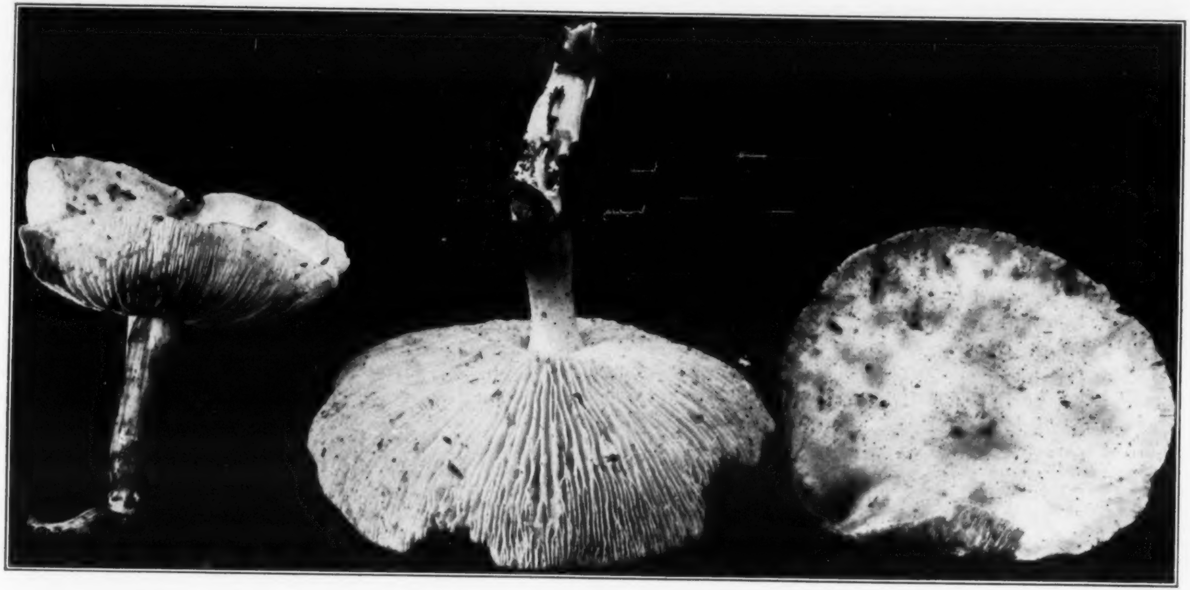
Introduction

The collection of edible fungi, commonly spoken of as mushrooms in contradistinction to the poisonous varieties known as toadstools, has become more and more popular during the past few years in America. On the one hand, the number of well-trained mycologists who undertake the study of fungi during the summer months as a scientific pastime, regardless of the dietetic value of the material they obtain, has been greatly augmented by those individuals who look everywhere for the edible species which they have learned to identify with great accuracy. In consequence, mushroom collecting has become something of a fad in many of our summer resorts and during September and October the fields and pastures are pretty thoroughly searched for such species as the meadow mushroom, *Agaricus campestris*. On the other hand, this country has seen, during the past decade, a great influx of peasants from Italy, Hungary and Bohemia where even the children know the difference between poisonous and harmless mushrooms. As a result, many of the edible species of fungi which grow in the woods are gathered by this foreign-born population either for themselves or for sale in the local markets. In consequence of this greater interest in the subject, mushroom poisoning has become somewhat more common in America despite the warnings issued from time to time, both to native Americans who are ignorant of the first principles of mycology, and to our foreign-born citizens who are misled by the variations in color and other properties which fungi exhibit in different countries. Poisoning by fungi, however, is by no means a modern occurrence. Indeed, mushrooms have been collected from time immemorial, according to Paulet,[1] in such countries as Russia, China, Hungary, Italy, and especially in Tuscany; being exhibited for sale in the public markets in cities like Pekin, St. Petersburg, and Florence.

It is also well known that the ancient Babylonians and the early Romans employed mushrooms in great quantity both as delicacies for the rich and as daily food for the poorer classes.

In early times, knowledge of the properties of fungi must have been gained entirely from experience and the accurate training of the peoples of the old world in the distinctions between the poisonous and harmless varieties could only have been obtained from many accidents. How common mushroom poisoning actually was, however, is not known to us. It must have been fairly frequent since the deaths of several notables from this cause have been recorded in history, not as occurring from some unexplained phenomenon but from accidents of a nature well-recognized by their contemporaries. Of such victims may be mentioned the family of the Greek poet Euripides, including his wife, two sons, and a daughter; Pope Clement VII; Emperor Jovian; Emperor Charles VI; Emperor Claudius; and a number of others.[2] Coming down to more modern times our first definite knowledge of the number of fatalities from mushrooms came from Paulet[1] who states that from the year 1749 to 1788 there were a hundred deaths in the environs of Paris alone. About the time of Paulet, Bulliard,[3] the celebrated French mycologist, began to systematize the knowledge of fungi possessed by men of his generation, established the various species upon firm ground, gave accurate descriptions of their botanical characters, and pointed out their physiological properties. Indeed, many of the species of the present day were established by this tireless French mycologist.

More recently, our knowledge of the extent to which mushroom fatalities may occur in France has been augmented by the publications of Bardy[4] who reported 60 cases in that district known as Les Vosges, and of Guillaud[5] who estimated the number of deaths in the southwest of France at about 100 annually. Falck[6] has also reported 53 cases in Germany with 40 deaths, and at the same time Inoko[7] in Japan has reported over 480 cases of mushroom intoxication in eight years. In this country Palmer,[8] of Boston, collected 33 cases with 21 deaths and Forster,[9] of Charlestown, 44 cases with 14 fatalities. Finally, in 1900 Gillot[10] found over 200 authentic cases of mushroom poisoning mostly in France and Ford,[2] a few years later, added nearly as many more found in the German,



COLLYBIA MACULATA (ALB. & SCHW.) QUÉL.

English and French literature since 1900. More recently Clark and Smith[11] have called attention to the great increase of mushroom poisoning in this country and have indicated that many of these cases take place within a few days' time. Thus, in September 1911, 22 deaths occurred in the vicinity of New York City in one period of ten days. The same point is also clear in the recent statistics given for France by Sartory[12] who records 249 cases of fungous poisoning with 153 deaths due chiefly to *Amanita phalloides* and a few *Entoloma lividum*. Of these, 90 per cent. occurred in the short time between August 26th and September 10th, 1912. Finally, one of the best of the modern French publications on poisonous fungi is that of Ferry[13] former editor of the Revue Mycologique who has given an excellent account of the most recent work in this field. A number of different species of mushrooms are poisonous, the symptoms which occur depending upon the presence of definite chemical substances in the plants. This can best be illustrated by a consideration of each species independently.

POISONING BY AMANITA PHALLOIDES BULLIARD

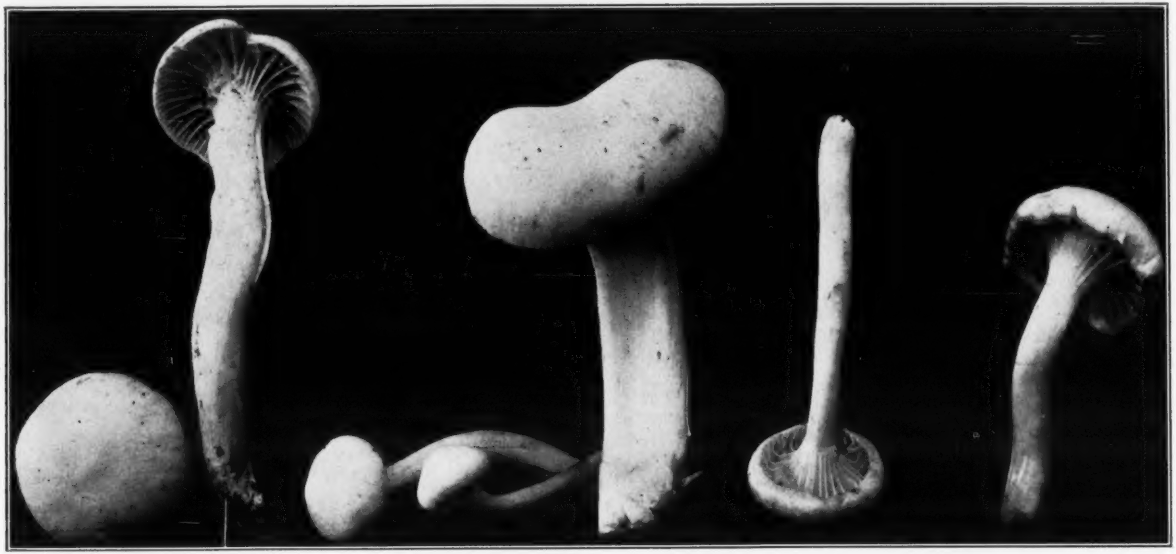
Botanical features

The vast majority of cases of mushroom intoxication are caused by *Amanita phalloides,* the white or deadly Amanita. The earlier species such as *Amanita bulbosa* Persoon and its varieties, *alba, citrina, virescens* and *olivacea, Agaricus bulbosus* Bulliard, *Amanita viridis* Persoon, *Amanita venenosa* Persoon and a number of others are without doubt identical with *Amanita phalloides*. In older French literature it is known as "l'orange ciguë," "l'orange blanche ou citronée," "l'orange ciguë jaunâtre" and "l'orange souris" and in the German as "Knollblätterschwamm." This species has a characteristic appearance and should be readily recognized by collectors of even limited experience. It usually grows to a height of 5–7 inches and its white spores, its ring or annulus and its base or cup (frequently called the poison cup) render its identification comparatively simple. The colors of the pileus, varying from brownish amber to yellow, are important, but are not as a rule regarded as of specific value. In Europe the pileus is usually greenish in color, but in America the green-

ish color is rarely seen. *Amanita phalloides* usually grows in the woods but this rule is by no means univeral. Occasionally, plants are to be found out in the open pastures near the margin of dense forests or in the grassy spots in the roads leading to and from them.

Clinical aspects

In poisoning by *Amanita phalloides* the clinical symptoms are practically always the same. After a prodromal stage of six to fifteen hours in which no discomfort is felt, the victims are suddenly seized by severe abdominal pain, cramp-like in character, and accompanied by vomiting and diarrhoea. Vomitus and stools consist of undigested food with much blood and mucus. Anuria is usually present and rarely constipation develops. Hemoglobinuria does not occur. Paroxysms of pain and vomiting alternate with periods of remission, the extreme suffering producing the Hippocratic facies described by the French as "la face vulteuse." The loss of strength is rapid and excessive. Jaundice, cyanosis, and coldness of the skin develop within a few days, followed by profound coma from which the patient does not rally. There is no fever. Convulsions are absent in the early stages and when present in the late stages are usually a terminal event. Ocular symptoms also do not usually occur. The course of the disease lasts four to six days in children and eight to ten in adults but if large quantities of the fungus are eaten a very profound intoxication develops and death may occur within 48 hours. The mortality in "phalloides" intoxication is extremely high, varying from 60 to 100 per cent., and is dependent somewhat upon the amount of the poisonous material ingested and probably somewhat upon the treatment. It requires surprisingly small quantities, however, to bring on fatal consequences and there are numerous deaths on record from eating one or two good-sized specimens. Plowright[14] has reported the death of a child of ten years from the consumption of about a third of the top of a small plant eaten raw. Recovery after ingestion of any quantity of *Amanita phalloides* may be regarded as extremely rare but not impossible. There is no difficulty in distinguishing between a poisoning due to this fungus from one due to other species such as *Amanita muscaria* since the entire clinical course of the disease is different.



HYGROPHORUS EBURNEUS (BULL.) FRIES

Autopsies upon individuals killed by *Amanita phalloides* have been carried out by a number of observers but our knowledge of the lesions is by no means satisfactory. There is little to be found to account for the violent paroxysms of pain, vomiting, and diarrhoea. Death seems to be due to the extreme fatty degeneration of the liver. The poisoning resembles most closely phosphorus poisoning (Ford[15]).

Poisonous constituents

The first attempt to obtain the active principle or poison of *Amanita phalloides* is probably that of Letellier,[16] who in 1826 obtained a heat-resistant substance from a number of fungi and to his investigations we owe the term amanitin. Many years subsequently he took up the work again in association with Speneux[17] examining this time a fungus known as *Hypophyllum crux melitense* (Paulet) and probably a variety of *Amanita phalloides*. In this investigation two substances were found, one of an irritating nature, acting upon the mucous membranes of the alimentary canal, and the other heat-resistant substance characterized as a glucosidal alkaloid and identical with the amanitin of Letellier. In 1866 Boudier[18] made an elaborate chemical analysis of *Amanita phalloides* obtaining about a dozen different substances. He ascribed the poisonous action of the plant to an alkaloid but was never able to isolate such a substance although he gave it the name bulbosine. Later, in 1877, Oré[19] also concluded, on biological grounds alone, that *Amanita phalloides* must contain an alkaloid and he gave this hypothetical poison the name phalloidin.

The observations of all these men are interesting now only historically as the names ascribed by these various investigators to the active principle of *Amanita phalloides* are no longer employed except occasionally in French literature. Modern knowledge of the properties of this plant dates from the work of Kobert[20] who established the important fact that extracts of *Amanita phalloides* contain a substance which lakes or dissolves the blood corpuscles of many animals and of man. There were certain serious objections to regarding this substance as the active principle, especially the fact that this blood-laking or hemolytic material is very easily destroyed by moderate heat, much less than is usually em-

ployed in cooking, and that individuals dying of *Amanita phalloides* intoxication do not show symptoms which are to be ascribed to this kind of a poison. Nevertheless, Kobert at once jumped to the conclusion that this blood-laking substance which he named phallin was the essential poison of the plant and his discovery was hailed everywhere as one throwing brilliant light upon this most obscure poisoning. The term phallin has gotten into mycological literature all over the world and the idea that *Amanita phalloides* intoxication is due to this remarkable substance which dissolves or eats up the blood corpuscles has something so romantic about it that few have cared to question the correctness of Kobert's conclusions. Kobert himself, however, discovered that blood-laking materials were lacking from many specimens which he afterwards collected and identified as *Amanita phalloides* but that the plants did contain an alcohol-soluble substance which was extremely poisonous to animals. This latter substance he regarded as an alkaloid while phallin he placed in the group of protein-like poisons known as toxalbumins.

Subsequent work upon *Amanita phalloides* has been conducted chiefly by American investigators. It was first shown by Ford[21] that extracts of *Amanita phalloides* contain the hemolytic material described by Kobert and in addition a heat resistant body which will reproduce in animals the majority of the lesions described in fatal cases of *Amanita phalloides* intoxication in man. These two substances were named by him the amanita-hemolysin and the amanita-toxin. The further chemical study upon the plant was carried out by Abel and Ford,[22] by Schlesinger and Ford[23] and Ford and Prouty.[24] According to their investigations *Amanita phalloides* always contains two poisons, the hemolysin and the toxin. The hemolysin is a highly complex glucoside, insoluble in alcohol, easily destroyed by heat and by the action of the digestive juices. While this substance may play a rôle in cases of phalloides intoxication in man there is little or no evidence that it does so under ordinary circumstances. It is present in such a great amount in the plant, however, that the possibility of its having a poisonous action when the fungus is eaten raw or when the digestive secretions are altered in character can not be entirely eliminated. The active principle of the plant is the

UPPER FIGURE. PSATHYRELLA DISSEMINATA (PERS.) QUÉL.
LOWER FIGURE. LACTARIA PIPERATA (L.) PERS.

alcohol-soluble toxin. This resists the action of heat, of drying, and of the digestive juices and reproduces in animals the lesions of phalloides intoxication in man. Chemically, the toxin cannot be characterized definitely but the purest preparations do not give the reactions of either proteins, glucosides, or alkaloids. Fungi cooked by the same methods which are employed in the kitchen are entirely free from hemolysin but have a poisonous action upon animals which is identical with that seen with the amanita-toxin. With our present knowledge the amanita-toxin may be regarded as the active principle or essential poison of *Amanita phalloides.*

Treatment

There is no satisfactory method of treating individuals poisoned by the deadly amanita. It is essential that competent medical advice be obtained as soon as possible and every effort made to rid the alimentary canal of the noxious material in the hope of doing so before enough poison is absorbed to bring on fatal results. Active emetics and purgatives should be administered at once and in case these are not effective the stomach should be washed out and the lower bowel irrigated. Even then, it is frequently impossible to prevent the absorption of the poison which takes place with great rapidity. In the later stages stimulants should be employed with great freedom in the hope of tiding the patient over the periods of weakness. Narcotics should be employed to relieve the intense pain and whenever convulsive movements are seen. *Atropin has no effect in Amanita phalloides intoxication* and no reliance should be placed upon the drug in poisoning by the deadly amanita. Efforts to manufacture a curative serum by the immunization of animals with the poisons in this fungus have thus far been unsuccessful.

POISONING BY OTHER WHITE AMANITAS

A number of other amanitas have poisonous properties identical in all respects with *Amanita phalloides.* The most important of these are *Amanita verna,* the " destroying angel " of Bulliard, which is far more common in America than the true *Amanita phalloides, Amanita virosa* Fries, *Amanita spreta* Peck and *Amanita phalloides* variety *citrina.* All these species are recognized to be deadly

poisonous. In addition there are some closely related amanitas which are either of known poisonous character or which have long been regarded as suspicious, the examination of which in the laboratory indicates the possession of definite poisonous action upon animals. This action should undoubtedly be ascribed to the amanita-toxin which is present in all these species in small quantities. This group includes *Amanita porphyria* Albertini & Schweinitz, *Amanita strobiliformis* Vittadini, *Amanita radicata* Peck, *Amanita chlorinosma* Peck, *Amanita mappa* (Batsch) Fries, *Amanita morrisii* Peck, *Amanita citrina* Persoon and *Amanita crenulata* Peck. In this group should also be placed *Amanitopsis volvata* (Peck) Saccardo. All these species should be put in the group of deadly poisonous mushrooms by mycologists and be sedulously avoided by collectors (Ford[25]).

Poisoning by Amanita muscaria Linnaeus

Botanical features

Poisoning by *Amanita muscaria* or the "fly agaric" is, next to that following the ingestion of *Amanita phalloides,* the most frequent variety of mushroom intoxication. This is primarily due to the great abundance of this species and its wide distribution over the surface of the world. The *Amanita muscaria,* in addition, more than other fungi is subject to great variations in color, size, and markings due to geographical distribution and seasonal changes. This may possibly account for the numerous accidents in America resulting from mistaking *Amanita muscaria* for *Amanita caesarea,* one of our most beautiful and highly prized edible amanitas. Accidents of this nature have occurred most frequently among foreigners, a fact which seems to indicate the closest resemblance between specimens of certain European species and other American species. The following description of *Amanita muscaria* taken from Farlow[26] brings out the essential botanical features of the plant and a little careful observation of growing fungi should enable collectors to distinguish *Amanita muscaria* from *Amanita caesarea* without hesitation. This is especially true in view of the yellow gills and striking white volva of Caesar's agaric.

"The fly agaric (*Amanita muscaria*), so called because decoc-

LEPIOTA NAUCINA (FRIES) QUÉL.

tions of it are used in killing flies, is in most places, at least in the northern and eastern parts of the country, a common species—often a good deal more abundant than the common mushroom. It is found during the summer along roadsides, on the borders of fields, and especially in groves of coniferous trees. It prefers a poor soil, of gravelly or sandy character, and occurs only exceptionally in the grassy pastures preferred by the common mushroom. It grows singly and not in groups, and attains a large size, being one of the most striking toadstools. It differs from the common mushroom in having gills which are always white, never pink or purple, and in having a hollow stem which is bulbous at the base and clothed with irregular, fringy scales on all the lower part. The pileus varies in color from a brilliant yellow to orange and a deep red, the yellow and orange being more frequent than the red. The surface is polished [and sometimes sticky], having scattered over it a larger or smaller number of prominent, angular warty scales, which can be easily scraped off. The gills and stalk are white, and there is a large membranous collar, which hangs down from the upper part of the stem."

Clinical aspects

The clinical features of poisoning by *Amanita muscaria* are quite as characteristic as those in *Amanita phalloides* intoxication and should enable physicians to distinguish clearly between the two conditions. Unfortunately, poisonous fungi are usually gathered by the ignorant who sometimes eat a number of different varieties and consequently the symptoms in the patients point to the combined action of different toxic principles. In general, however, there is no difficulty in recognizing the character of the intoxication. In *Amanita muscaria* poisoning there is usually a very short interval between the ingestion of the fungi and the first signs of trouble. This prodromal stage varies from one or two to five or six hours depending upon the amount of the fungi eaten. Careful observation of this feature will frequently be of the greatest value in deciding upon the kind of intoxication which the cases present. In the severe cases the patients show an excessive salivation and perspiration, a flow of tears, nausea, retching, vomiting and diarrhoea with watery evacuations. The pulse may

rarely be quickened, but it is usually slow and irregular. There is no fever. The respirations are accelerated and the patients dyspnoeic, the bronchi being filled with mucus. Mental symptoms are also present, particularly giddiness with confusion of ideas and rarely hallucinations. All these symptoms may vary in their intensity, at some times the gastro-intestinal predominating and at other times the mental. In light cases, where small quantities of the poisonous fungi are consumed, only an excessive salivation or perspiration may be noticed, with uneasiness and discomfort in the stomach and bowels, the symptoms subsiding spontaneously in a few hours. In the severe cases, the vomiting and diarrhoea may be so pronounced as to rid the alimentary canal of the offending material and the nervous symptoms then become the predominant ones. With large quantities of poison also the patients may show the nervous manifestations from the start, delirium, violent convulsions, and loss of consciousness developing in rapid succession and the patients sinking into a coma from which they can be roused with difficulty if at all. Rarely, consciousness is retained till the end, the patients dying from a paralysis of respiration. Finally, in many cases, after the preliminary attack of vomiting and diarrhoea, the patients sink into a deep sleep from which they wake several hours later profoundly prostrated but on the road to recovery. In such cases the effect of the poisoning passes off rapidly, the patients being restored to normal health within two or three days. There are no late effects or after-effects in *Amanita muscaria* intoxication, and the prognosis is always good if the patients recover from the preliminary symptoms. Chronic lesions such as develop in *Amanita phalloides* intoxication and are to be referred to the degenerative changes in the internal organs, do not occur with *Amanita muscaria*.[27] Rarely, the nervous manifestations of "muscaria" intoxication become much more pronounced than the alimentary and the patients become the victims of excitement and hallucinations evidencing many of the symptoms of alcoholic intoxication. This variety of poisoning is particularly common in Siberia where decoctions of *Amanita muscaria* are employed to induce orgies of drunkenness in which the most disgusting practices are followed, according to Kennan.[28] The physiological effect of the Siberian *Amanita muscaria* has

AGARICUS CAMPESTER HORTENSIS COOKE

never been clearly understood and the symptoms shown by the Koraks who employ the fungus as an intoxicant are seldom seen either in Europe or in America. Possibly the method of preserving the plants may alter the poisonous principles in them or possibly the Siberian plants do not contain the same poisonous substances as the European or American varieties. Death, however, is by no means an infrequent occurrence among the Koraks from an overdose of *Amanita muscaria* and, as we shall see later, the active principle of the European plants, muscarin, has also been obtained from the Siberian.

Autopsies upon individuals dead from the ingestion of *Amanita muscaria* have revealed surprisingly little. The pathological changes in the internal organs seen with *Amanita phalloides* are lacking, particularly the hepatic lesions. In general, the findings point to the action of a profound nerve poison (Ford[2]).

Poisonous constituents

As has already been indicated most of the early work upon the poisons in fungi was conducted upon poorly identified plants or upon lots of fungi containing a number of species, and it was not until the middle of the last century that any satisfactory work was accomplished upon *Amanita muscaria*. In 1869 Schmiedeberg and Koppe[29] took up the study of this fungus, investigating its poison from both the chemical and pharmacological standpoint. By the most careful work they showed that *Amanita muscaria* contains an active principle of definite chemical composition which they called muscarin. This was at first regarded as an alkaloid of the same general nature as strychnin and morphin but later work has shown that it is probably a complex ammonia derivative. Muscarin is an extremely active substance and is present in the fungus in but small amounts. Nevertheless, it is able to exert its characteristic effect, frequently with fatal outcome. Its principal action is upon the various organs of the body through the nervous system. It produces an increased secretion from the mucus membranes and from various glands, for instance, by its stimulation of the terminal filaments of the secretory nerves, and at the same time a paralysis of the heart and respiration by a corresponding stimulation of the inhibitory nerve endings of the

vagus nerve. Atropin by its depressing action upon the same nerves which muscarin stimulates, is a perfect physiological antidote for the muscarin found in *Amanita muscaria* and also for synthetic muscarin which may be prepared by the oxidation of cholin. Its use, therefore, was at once suggested in *Amanita muscaria* poisoning.

The work of Schmiedeberg and Koppe upon *Amanita muscaria* was not accepted at once, nor did it fail to arouse considerable opposition. The cases of poisoning by this fungus presented such varied symptoms that it did not seem possible that they could all be referred to the one substance muscarin and this was particularly true in regard to the Siberian *Amanita muscaria.* It was soon shown by Schmiedeberg,[30] however, that the Russian fly amanitas had the same action upon animals as the European type and he was able to isolate muscarin from them. In addition to muscarin, however, Schmiedeberg[31] found later in this fungus evidences of another substance differing from muscarin in producing a dilatation of the pupils, thus acting like atropin. This second substance Schmiedeberg called muscaridin, and he believed that its presence in *Amanita muscaria* in greater or less amount would modify the action of the muscarin and thus the differences in intensity of the symptoms in *Amanita muscaria* poisoning would be explained. Muscaridin was later named "pilz-atropin" by Kobert[32] who states that it can be separated from commercial muscarin by its solubility in ether. It has, however, never been isolated from fresh *Amanita muscaria* plants. Finally, Kunkel[33] and other authorities maintain that the differences shown by the various cases of *Amanita muscaria* intoxication are due to the presence in the plant, in addition to muscarin, of a mixture of chemically related substances having entirely different pharmacological effects. This would account for the fact that atropin does not wholly neutralize the toxic action of *Amanita muscaria* upon animals despite the fact that it is a perfect physiological antidote for muscarin itself. This led Harmsen[34] to take up the question again and he has recently been able to show that extracts of *Amanita muscaria* are twice as toxic weight for weight as pure muscarin, and contain a poison which produces in animals long continued convulsions with a fatal outcome, this effect not being

neutralized by atropin. This poison Harmsen calls the "pilztoxin." Its presence in *Amanita muscaria* has never been confirmed but some of the evidence, clinical and otherwise, indicates that muscarin may not be at all times the sole poison in *Amanita muscaria*.

It should be noted in this connection that the term muscarin is not the name of a specific chemical substance, but of a group of at least five substances with the same formula $C_5H_{15}NO_2$ and that the effects of these various compounds upon the animal organism are quite different from each other.* A complete discussion of the various muscarins, their properties and manner of preparation may be found in the works of Zellner[35] and Kobert.[32]

Treatment

The outlook in poisoning by *Amanita muscaria* is more hopeful that when *Amanita phalloides* has been ingested, because of the lack of chronic and degenerative lesions produced by the latter species. *Amanita muscaria* causes an acute intoxication which comes on soon after the ingestion of the fungus, develops rapidly, and is amenable to treatment. As we have indicated above, atropin is a perfect physiological antidote for muscarin. Whenever, therefore, the patients show evidence of muscarin poisoning such as lacrymation, salivation, contraction of the pupils, delirium, hallucinations, and coma, atropin should be administered at once and in large doses. At the same time the stomach and bowels should be emptied of the ingested material by the free use of emetics and purgatives. Even though the vomiting and diarrhoea are pronounced, drugs should be employed to increase this action since it is essential that all the fungi be removed and the absorption of poison be prevented. In refractory cases with bad heart action, respiratory distress and coma, atropin should be administered

* The bases cholin and neurin are closely related to muscarin and have both been reported in mushrooms. Neurin is very poisonous. According to Harnack (Arch. exp. Path. u. Pharmacol., 4, pp. 82 and 168 (1875)) the amanitin of Letellier and Speneux[17] is cholin. Clark and Kantor[40] found cholin in *Amanita muscaria* and other fungi. Hofmann (Dissertation, Zurich, 1906) discovered neurin in *A. muscaria*, but it is not certain whether it exists as such in the fungus or whether it is produced by processes of decomposition. The deadly prussic acid has been found in *Marasmius oreades* and *Clitocybe infundibuliformis* by Offner (Bull. Soc. Mycol. de France, 27, 242, 1912).

intravenously. In such cases atropin, indeed, offers the only hope of saving the patient's life. If the symptoms seen in cases of fungus intoxication do not point clearly to muscarin as the chief cause of the trouble but rather to other poisonous principles such as the pilz-atropin of Schmiedeberg and Kobert atropine naturally should not be administered. Finally, whenever the patients show symptoms referable to such poisons as Harmsen's "pilztoxin" stimulants should be freely administered to tide the patients over periods of weakness and depression.

AMANITA PANTHERINA De Candolle

Amanita pantherina is a common amanita in Europe, particularly in France and Germany where it is regarded as a deadly poisonous species. Boehm[36] has isolated muscarin from this plant in Germany so that the active principle is probably the same as that of the "muscaria." The species is very common in Japan and Inoko[7] believes that it represents *Amanita muscaria* there. Poisoning is quite frequent in that country from its accidental consumption but the symptoms are by no means the same as with the true "muscaria." Delirium and hallucinations with visions of beautiful vari-colored objects predominate over the gastro-intestinal symptoms, the effects being a little like those described for the Siberian "muscaria." The "pantherina" is also said to be used in Japan to produce mushroom drunkenness. Inoko has isolated muscarin from the Japanese *Amanita pantherina* and has also found in it a substance like the "pilz-atropin" of *Amanita muscaria. Amanita pantherina* is not common in America but Atkinson[37] believes that his species *Amanita cothurnata* may represent a light colored form of "pantherina" here. In the only report upon *Amanita pantherina* thus far published in America (Ford and Sherrick[38]) no evidence was presented to show that our species contains muscarin. For the present both the real "pantherina" and Atkinson's "cothurnata" should be avoided by collectors. Should symptoms of muscarin intoxication follow their ingestion, the treatment should be along the lines already indicated, namely, complete evacuation of stomach and bowels and large doses of atropin.

EDIBLE AMANITAS

Certain varieties of amanitas have long been known to be edible and indeed have been highly prized by epicures. The most important species of this character are *Amanita caesarea* (Caesar's agaric), *Amanita rubescens* Persoon and *Amanita junquillea* Quelet. No report has appeared in the literature in regard to the chemical properties of *Amanita caesarea* but Ford[39] has shown that *Amanita rubescens* has no toxic action upon animals. *Amanita junquillea* likewise is free from poisonous properties (Ford and Brush[40]). Such species, while possibly safe in the hands of experts should not be collected by amateurs owing to the difficulty in properly identifying them. There are also a number of amanitas which have no poisonous action upon animals, the properties of which have not been clearly established by experience. Among such species are *Amanita frostiana* Peck (Ford[25]) and *Amanita solitaria* Bulliard (Ford[39]). Owing to the resemblance of *Amanita frostiana* to *Amanita muscaria* and to the difficulties in the recognition of *Amanita solitaria* it would be unwise to recommend either of these species. Much the same may be said of *Agaricus amygdalinus* Curtis possibly identical with *Agaricus fabaceus* Berkeley which causes unpleasant symptoms on ingestion but which has never been reported as causing serious illness (Ford and Sherrick[38]).

LEPIOTA MORGANI Peck

The "green-spored" lepiota is a handsome plant growing with great freedom in the Ohio valley. In its favorite localities *Lepiota morgani* thrives in grassy pastures as well as in woods and this fact has been the cause of confusing it with the edible *Agaricus campestris*. The green spores of this fungus ought to serve as a sufficiently striking characteristic to prevent mistaking it for any edible fungus. Chestnut[41] has collected evidence that showed that *Lepiota morgani* often has caused serious illness and at least one death. His physiological experiments indicated that specimens of this plant from the District of Columbia were definitely poisonous to animals and that heating destroyed the greater part of its toxic properties.

CLITOCYBE ILLUDENS Schweinitz

There has always been a tradition that this species is poisonous and not pleasant to eat. Several cases of poisoning from its consumption are recorded but it seems not to have caused fatal results. *Clitocybe illudens* grows in clumps at the base of tree trunks where its bright orange-brown color and phosphorescent glow at night seem to have attracted unfavorable attention. Ford[42] has reported that this fungus produces an acute intoxication in guinea pigs and that boiling the extracts of the plant seems to destroy the toxic properties as is sometimes the case with *Amanita muscaria*. Recently Clark and Smith[11] have investigated *Clitocybe illudens* and have found that upon the exposed frog heart it exerts a typical muscarin effect, which is neutralized at once by the application of atropin solutions. On the whole we may safely say that *Clitocybe illudens* is a dangerous fungus since it contains a muscarin-like substance having a powerful action on the nervous system.

CLITOCYBE DEALBATA SUDORIFICA Peck

The original species, *Clitocybe dealbata* Sowerby, has usually been considered harmless but Peck[43] investigated a reported case of poisoning by it and has found that a form of *Clitocybe dealbata* causes profuse perspiration and discomfort. In consequence, Peck gave this form the varietal name *sudorifica* and advised caution in its use as food. Ford and Sherrick[44] have found that this fungus causes effects upon animals that are nearly identical with those produced by *Amanita muscaria*. As mentioned in the discussion of *Clitocybe illudens*, Clark and Smith have found that *Clitocybe illudens* shows a typical muscarin action also; therefore it seems likely that these two clitocybes may contain nerve poisons nearly as active as muscarin.

LACTARIUS TORMINOSUS Fries

As a general rule, specimens of the genus *Lactarius* are edible but this particular species has always been looked upon askance by mushroom eaters because of the painful gastro-intestinal disorders it causes. Ford[42] has studied its action on animals and has demonstrated that it can produce an acute intoxication with only

a few of the characteristic muscarin symptoms. It is worthy of note that the poison is destroyed by heating, as previously reported by Kunkel.[45] Goldman[46] has reported cases of poisoning by *Lactarius torminosus* in Germany.

RUSSULA EMETICA Fries

The tendency of this brilliant species to cause gastro-intestinal disturbances with vomiting is well known and this reputation has prevented its use as food. Kobert[32] has isolated three basic substances from it; cholin, muscarin, and an atropin-like substance already mentioned in the discussion of *Amanita muscaria*. The emetic properties of this fungus are usually sufficient to cause its expulsion as soon as the material reaches the stomach and thus prevent absorption of the poison.

PHOLIOTA AUTUMNALIS Peck

Peck[47] has called attention to the fact that this supposedly harmless mushroom may be the cause of fatal poisoning and Ford and Sherrick[38] have studied its action on animals and have shown that it is acutely toxic to them. At the autopsy the hearts were found greatly dilated in every case and atropin did not neutralize this peculiar heart-dilating effect. Evidently the poison is a powerful one of unknown nature.

INOCYBE INFIDA (Peck) Earle

This is so small a plant that it is not likely to fall into the hands of mushroom eaters. Murrill,[48] however, has recorded the poisoning of a family of several persons who had eaten *Inocybe infida* by mistake for another similar but edible fungus. Clark and Kantor[49] have isolated from this plant, by methods planned to extract muscarin from *Amanita muscaria,* a small amount of a poison causing long continued paralysis in frogs. The symptoms shown by the frogs were not typical of muscarin but did indicate a definite and powerful action on the nervous system. In a later series of experiments Clark and Smith[11] applied the same extraction methods to both *Inocybe infida* and *Clitocybe illudens,* obtaining substances which had a characteristic muscarin effect upon the frog's heart, the effect being neutralized by atropin. Further

investigations are needed upon these fungi to determine more clearly the relationship of their toxic principles to those found in *Amanita muscaria.*

INOCYBE INFELIX Peck

While this plant has never been investigated from the standpoint of edibility, it has been shown by Ford[42] that it contains a definite poison for both rabbits and guinea pigs, which resists desiccation and boiling. In these animals the fungous extract in small doses produced a deep sleep from which they awoke in a few hours apparently well, while with large doses profound and acute intoxication developed from which they died in a short time. The animals did not show the characteristic "muscaria" effects and Ford was therefore led to conclude that *Inocybe infelix* contained a narcotic poison of some sort. Further work is required in regard to the qualities of this species, particularly since the symptoms noted in the poisoned animals are not entirely inconsistent with muscarin poisoning.

INOCYBE DECIPIENS Bresadola

This fungus has not thus far been tested for edibility, but it has been shown by Ford and Sherrick[38] that it contains a poison belonging to the muscarin-pilocarpin series. In large animals it causes an acute intoxication resembling that produced by *Amanita muscaria* with lacrymation, salivation, contracted pupils, and labored respiration as the chief symptoms. Upon the frog's heart the fungus extracts had the typical "muscaria" effect causing a stoppage in diastole which was neutralized by atropin. *Inocybe decipiens* should, therefore, be grouped with the deadly poisonous fungi, as liable to contain muscarin.

THE HEBELOMAS

Kobert[50] states that both *Hebeloma rimosum* and *Hebeloma fastibile* contain muscarin-like poisons, the nature of which is unknown. Mycologists have usually regarded the genus Hebeloma as unfit for food. At the present time little is known of American specimens of this group, either from the systematic or toxicological standpoint.

THE ENTOLOMAS

In Europe, both *Entoloma lividum* and *Entoloma sinuatum* are classed among the poisonous fungi. According to a recent collection of cases by Sartory[12] in France, *Entoloma lividum* is an extremely dangerous fungus, causing severe illness and occasionally death. Sartory believes that *Entoloma lividum* is nearly as poisonous as some of the various forms of *Amanita phalloides.*

THE PANAEOLUS SPECIES

In this group, *Panaeolus papillionaceus* and *Panaeolus retirugis* are reputed to produce hilarity and a mild intoxication in man. Ford[42] has studied an American form of *Panaeolus retirugis* and has found it to be poisonous to guinea pigs, producing in them a peculiar kind of intoxication which resulted in death but left no lesions apparent at autopsy.

BOLETUS LURIDUS Schaeffer

Among the usually harmless Polyporaceae this species has always had an unsavory reputation. Boehm[36] has isolated muscarin from *Boletus luridus* and has thus shown that there is good ground for including this boletus among the poisonous fungi. *Boletus luridus* is not a common plant in America and may not exist here at all in the form found in Europe.

BOLETUS SATANUS Lenz

Besides the *Boletus luridus* just mentioned it is likely that *Boletus satanas* also contains a poisonous principle· Utz[51] found a basic substance in this fungus and named it boletin but from its chemical properties and its physiological action we may conclude that he probably was dealing with muscarin. Like *Boletus luridus* it is uncertain whether this species occurs in America. It is often said that one is never in danger from eating any boletus but the possibility of muscarin occurring in some of this group is enough to cause one to use caution in eating unfamiliar species, even if nothing worse than gastro-intestinal disturbances are produced.

BOLETUS MINIATO-OLIVACEUS Frost

In 1899 Collins[52] reported cases of poisoning from eating *Boletus miniato-olivaceus* variety *sensibilis* but nothing more was learned of this species until recently when Ford and Sherrick[44] made experiments with it. They showed that extracts from the plant killed guinea pigs in several days but that rabbits were not affected. The guinea pigs became emaciated but nothing characteristic was noted at autopsy.

POLYPORUS OFFICINALIS Fries

From this polypore a definite poisonous substance has been isolated, having the name agaricinic acid, and the chemical formula $C_{14}H_{27}OH(COOH)_2$. This substance is used to a small extent in medicine to lessen excessive perspiration but cannot be given in large doses as it causes vomiting and purging by its strong irritating effect upon the mucous membranes. Jahns[53] and also Hofmeister[54] have made careful studies on the preparation and the physiological action of agaricinic acid.

GYROMYTRA ESCULENTA FRIES

Years ago the poisoning from the false morel was reported frequently in Germany but within the past few years the only note of such accidents is that of Lövegren[55] who has described several cases in which the lesions pointed to a hemolytic intoxication. The action of this fungus upon man and upon animals is by no means definite, however, and much work must be done before the matter is clarified. The European variety of the false morel, *Morchella esculenta* or *Gyromytra esculenta,* has been shown by the researches of Boehm and Külz[56] to contain a hemolytic poison, helvellic acid, and this agrees with the observations which have been made clinically. Accidents from poisonous morels have not been reported in America and no observations have thus far been made with this fungus collected in America except on one occasion (Ford and Sherrick[38]) when it was found to have no hemolytic action or poisonous effect upon animals.

PROPHYLAXIS

Mushrooms are usually eaten for their flavor which makes them an agreeable relish and food-accessory rather than a staple article

of diet. There is no general cook-book test to distinguish the dangerous fungi from the edible ones. The habits and appearance of the poisonous species must be studied until one may recognize them with the same ease and certainty as any of the common plants of our gardens. Neglect of this precaution in gathering mushrooms for the table will sooner or later cause a typical attack of poisoning, and in such cases it should be remembered that the mortality is often as high as in any of the most fatal diseases. The rapidly increasing number of deaths in this country from mushroom poisoning shows that some effort must be made to disseminate exact information about the dangerous species in order to prevent unnecessary suffering and death.

There is a tradition in this country and Europe that treating *Amanita muscaria* (Coville[57]) with vinegar and salt water removes the poisonous constituents. This treatment if repeated several times would probably remove muscarin and similar substances but the danger from incomplete extraction of the poison is still too great to recommend its use. In the case of *Amanita phalloides,* Radais and Sartory[58] have shown that such treatments do not reduce the toxicity of the fungus in spite of popular belief to the contrary. There is little doubt that in some countries people habitually eat *Amanita muscaria* in small quantities, both treated and untreated, with no apparent signs of poisoning, but this does not warrant us in ever allowing ourselves to experiment upon the edibility of such poisonous fungi. Generally, in this country, no one eats *Amanita muscaria* because of its well known dangers. In some of our investigations (Clark and Smith[11]) on American specimens of this plant from different localities we found apparently great differences in toxicity, possibly due to local variation. Furthermore, under certain conditions, heat may destroy the poisons in *Amanita muscaria* as reported by Ford[42] and others, but neither does this observation warrant us in concluding that the dangers from eating this fungus are overestimated.

The first necessary prophylactic measure is to impress upon mushroom lovers that *there is no easy empirical test to distinguish between the edible and poisonous fungi.* No one should eat an unfamiliar mushroom until it has been identified as a harmless species by a well-trained mycologist. It is not difficult to learn

to know fungi at a glance if one is willing to study them closely and to remember the points of difference in form, color, and habit among the various species. Unfortunately, there are a few "mushroom handbooks" in this country, which are unfailing sources of misinformation, and they have evidently been written by people of no training and poor judgment. In one case, color plates of *Amanita muscaria* and *Amanita caesaria* have the names of these two species transposed. Identifications based on pictures are dangerous unless the publication of such unreliable books is prevented. After all, the number of poisonous species is very small and when they are eliminated there are still many desirable fungi which are perfectly safe esculents.

So far we have mentioned only the prophylactic measures to be taken in eating wild mushrooms gathered in the fields, but there is a broader phase to be considered; this is the question of mushrooms in the public markets. If these markets are supplied by wild fungi gathered for the purpose it is necessary to see that no poisonous species become mixed with the others. In European countries many of the public markets have an official mushroom inspector, whose duty it is to examine all lots of fungi before they are exposed for sale and to condemn all fungi not known to be entirely harmless to man. With the increasing taste for mushrooms in this country and the larger stocks carried during the season, it may become necessary for us to control our mushroom supply in a similar manner. Several deaths have been caused by poisonous fungi bought in our public markets.

Even the use of cultivated mushrooms does not guarantee immunity from trouble by poisoning since it is believed by several investigators that harmless fungi may become poisonous if kept too long before consumption (Kobert[59]). This often happens in markets and restaurants where mushrooms become slightly decomposed before they can be sold. Another danger is that cooked mushrooms may develop toxic properties after being kept during the summer weather and again served at subsequent meals (Frey[60]). On chemical ground it is easy to see that the unstable nitrogenous substances in edible fungi could easily be changed into toxic constituents by the action of microörganisms. This is another matter that ought to be studied by chemical and pharma-

cological methods before we can feel at all satisfied with our present knowledge of the properties of poisonous mushrooms.

BIBLIOGRAPHY

1. **Paulet:** Traité des champignons. Paris, 1793.
2. **Ford:** A clinical study of mushroom intoxication. Johns Hopkins Hosp. Bull., Vol. XVIII, pp. 123–130, 1907.
3. **Bulliard:** Histoire des champignons de France. Paris, 1791–1812.
4. **Bardy:** Bull. Soc. Philomat. des Vosges, Vol. IX, 1883–1884.
5. **Guillaud:** Bull. Soc. Mycolog. de France, Vol. 1, p. 123, 1885.
6. **Falck:** Handbuch der gesammten Artzneimittellehre mit Einschluss der Toxicologie, Bd. 1, Heft 12, p. 282.
7. **Inoko:** Über die giftigen Bestandtheile und Wirkungen des japanischen Pantherschwammes. Mittheil. a. d. med. Fac. d. K. Jap. Univ. Tokio, Bd. I, No. 4, pp. 313–331, Tokyo, 1890. See also No. 3, pp. 277–306, 1889.
8. **Palmer:** Quoted by Forster in Medical Communications to the Mass. Med. Soc., Vol. 15, p. 209, 1890.
9. **Forster:** Mushrooms and mushroom poisoning. Bost. Med. and Surg. Jour., Vol. 123, pp. 267–272, 1890.
10. **Gillot:** Étude médicale sur l'empoisonnement par les champignons, Lyon, 1900.
11. **Clark and Smith:** Toxicological studies on the mushrooms Clitocybe illudens and Inocybe infida. Mycologia, Vol. V, pp. 224–232, 1913.
12. **Sartory:** Les empoisonnements par les champignons (Été de 1912), Paris, 1912.
13. **Ferry:** Étude sur les amanites—Les amanites mortelles. Suplement à la Revue Mycologique, 1911.
14. **Plowright:** Case of fatal fungus poisoning—By Agaricus [Amanita] phalloides. Lancet, Vol. 2, p. 941, 1879.
15. **Ford:** The pathology of Amanita phalloides intoxication. Jour. of Infect. Dis., Vol. 5, pp. 116–132, 1908.
16. **Letellier:** Dissertation sur les propriétés, médicales et vénéneuses des champignons, etc., Paris, 1826.
17. **Letellier and Speneux:** Recherches sur les principes toxiques des champignons. Annales d'hyg. pub. et de med. leg., Series II, Tome 27, pp. 71–75, 1867.
18. **Boudier:** Les champignons au point de vue de leurs caractères usuels, chimiques, et toxicologiques, 1866, Paris.
19. **Oré:** Recherches experimentelles sur l'empoisonnement par l'agaric bulbeux. Arch. de Phys. norm. et path., Series II, Tome 4, ninth year, pp. 274–309, Paris, 1877.
20. **Kobert:** Über Pilzvergiftung. St. Peters. med. Wochnschr., Bd. XVI, pp. 463 and 471, 1891. See also reference No. 59.
21. **Ford:** The toxines and antitoxines of poisonous mushrooms. Jour. of Inf. Dis., Vol. III, pp. 191–224, 1906.
22. **Abel and Ford:** On the poisons of *Amanita phalloides*. Jour. of Biol. Chem., Vol. II, pp. 273–288, 1907. See also: Further observations on the poisons of *Amanita phalloides*. Arch. f. exper. Path. u. Pharm., "Schmiedeberg-Festschrift, 1908," pp. 8–15.

23. **Schlesinger and Ford:** On the chemical properties of *Amanita phalloides*. Jour. of Biol. Chem., Vol. III, pp. 279–283, 1907.
24. **Ford and Prouty:** Note on the Amanita-toxin. Jour. of Pharm. and Exper. Ther., Vol. 1, p. 389, 1909.
25. **Ford:** The distribution of poisons in the amanitas. Jour. of Pharm. and Exper. Ther., Vol. 1, pp. 275–287, 1909.
26. **Farlow:** Some edible and poisonous fungi, Bulletin No. 15, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, Washington, 1898.
27. **Prentiss:** Five cases of mushroom poisoning, three of which proved fatal; treatment of the poisoning. Phila. Med. Jour., Vol. 2, p. 607. See also Ford (2).
28. **Kennan:** Tent life in Siberia. New edition (1910), pp. 198–200, New York.
29. **Schmiedeberg and Koppe:** Das Muskarin, Leipzig, 1869.
30. **Schmiedeberg:** See Harnack, Untersuchungen ueber Fliegenpilzalkaloide. Arch. f. exp. Path. u. Pharm., Bd. IV, pp. 168–190, 1875.
31. **Schmiedeberg:** Bemerkungen über die Muskarinwirkungen. Arch. f. exp. Path. u. Pharm., Bd. XIV, s. 376, 1881.
32. **Kobert:** Lehrbuch der Intoxikationen, 2d ed., Bd. II, Heft 2, p. 1224, 1906.
33. **Kunkel:** Handbuch der Toxicologie. Bd. II, p. 1049, Jena, 1901.
34. **Harmsen:** Zur Toxicologie des Fliegenschwammes. Arch. f. exp. Path. u. Pharm., Bd. 50, p. 361, 1903.
35. **Zellner:** Chemie der höheren Pilze, pp. 59–70, Leipzig, 1907.
36. **Boehm:** Beiträge zur Kenntniss der Hutpilze in chemischer und toxicologischer Beziehung. Arch. f. exp. Path. u. Pharm., Bd. 19, p. 60, 1885.
37. **Atkinson:** Mushrooms, edible and poisonous. Second ed., p. 66, New York, 1903.
38. **Ford and Sherrick:** Further observations on fungi, particularly *Clitocybe sudorifica* Peck, *Pholiota autumnalis* Peck, and *Inocybe decipiens* Bresadola. Jour. of Pharm. and Exper. Ther., Vol. IV, p. 321, 1913.
39. **Ford:** On the presence of hemolytic substances in edible fungi. Jour. of Infect. Dis., Vol. 4, p. 434. 1907.
40. **Ford and Brush:** In press. Jour. of Pharm. and Exp. Ther., 1914.
41. **Chestnut:** Poisonous properties of the green-spored Lepiota. Asa Gray Bull., Vol. 8, pp. 87–93, 1900.
42. **Ford:** The distribution of haemolysins, agglutinins and poisons in fungi, especially the Amanitas, the Entolomas, the Lactarius, and the Inocybes. Jour. of Pharm. and Exp. Ther., Vol. II, p. 285, 1911.
43. **Peck:** Report of the State Botanist, 1910. New York State Museum Bulletin No. 150, p. 43, 1911.
44. **Ford and Sherrick:** On the properties of several species of the Polyporaceae and of a new variety of Clitocybe, *Clitocybe dealbata sudorifica* Peck. Jour. of Pharm. and Exper. Ther., Vol. II, p. 549, 1911.
45. **Kunkel:** Handbuch der Toxicologie, Bd. II, p. 1053.
46. **Goldman:** Ueber Vergiftung mit dem Giftpilze *Agaricus torminosus*. Wien. klin. Wochnschr., Bd. XIV, p. 279, 1901.
47. **Peck:** Report of the State Botanist 1911. New York State Museum Bulletin 157, p. 9, 1912.

48. **Murrill:** A new poisonous mushroom. Mycologia, Vol. 1, p. 211, 1909.
49. **Clark and Kantor:** Toxicological experiments with some of the higher fungi. Mycologia, Vol. III, p. 175, 1911.
50. **Kobert:** Lehrbuch der Intoxikationen, 2d ed., Bd. II, Heft 2, p. 621, 1906.
51. **Utz:** Beiträge zur Kenntnis giftiger Pilze. Apoth. Zeitung, Vol. 20, p. 993, 1905.
52. **Collins:** A case of Boletus poisoning. Rhodora, Vol. 1, p. 21, 1899.
53. **Jahns:** Zur Kenntniss der Agaricinsäure. Arch. f. Pharm. (3d ser.), Bd. 21, p. 260–271, 1883.
54. **Hofmeister:** Ueber den schweissmindernden Bestandtheil des Lärchenschwammes. Arch. exp. Path. u. Pharmacol., Bd. 25, pp. 189–202, 1889.
55. **Lövegren:** Die Lorchelintoxikationen. Jahrb. f. Kinderheilk., Bd. XIX, p. 412, 1909.
56. **Boehm and Külz:** Ueber den giftigen Bestandtheil der essbaren Morchel (*Helvella esculenta*). Arch. f. exp. Path. u. Pharm., Bd. XIX, p. 403, 1885.
57. **Coville:** Observations on recent cases of mushroom poisoning in the District of Columbia. Circular No. 13, Division of Botany, U. S. Department of Agriculture, Washington, 1898.
58. **Radais and Sartory:** Toxicité de *l'Amanita phalloides*. Comp. Rend. Acad. Sci., Vol. 153, pp. 1527–9, 1912.
59. **Kobert:** Lehrbuch der Intoxikationen, "Giftschwämme," 2d ed., Bd. II, Heft 2, pp. 614–31, Stuttgart, 1906.
60. **Frey:** Zwei tödliche verlaufene Fälle von Pilz-vergiftung, etc. Zeitsch. f. klin. Med., Vol. 75, pp. 455–471, 1912.

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STUDIES IN NORTH AMERICAN PERONOSPORALES—VI. NOTES ON MISCELLANEOUS SPECIES

GUY WEST WILSON

(WITH PLATES 135 AND 136, CONTAINING 22 FIGURES)

KAWAKAMIA Miyabe; Miyabe & Kawak. Bot. Mag. Tokyo **17**: (306). 1903

This genus was established for the *Cyperus*-inhabiting species, *Peronospora Cyperi.* This fungus which is a native of Japan has been collected once at Pierce, Texas, on imported plants of its host, *Cyperus tegetiformis* Roxb. According to its author the genus is closely related to *Phytophthora.* Through the courtesy of Mrs. Flora W. Patterson the writer was enabled to make a careful study of both American and Japanese material of the species in the herbarium of the Bureau of Plant Industry. While the measurements of the American specimens are slightly larger than those of the Japanese, there is no question as to their identity. The conidia present a striking likeness in outline to those of *Phytophthora,* but the pedicel is more conspicuous than in any species of this last genus.

The genus *Kawakamia* appears to the present writer to agree more closely with *Basidiophora.* In *Basidiophora* the conidiophore is much enlarged at the apex, and bears a number of cylindric branches on each of which a large, oval, papillate is produced. This conidium breaks away with a portion of the so-called basidial branch adhering as a pedicel-cell much as in the case of the teliospores of the Uredinales. In *Kawakamia* the conidiophore is somewhat different, but strikingly similar. The conidiophore is simple and bears a single conidium on a portion of the conidiophore which is differentiated from the remainder of the hypha both in size and structure. In appearance and structure the fertile portions of the conidiophores both of *Basidiophora* and of *Kawakamia* are similar. In each genus the conidia fall away with the pedicel-cell attached. As these characters are so similar in the

two genera we may characterize *Kawakamia* as *Basidiophora* without the apical clavate enlargement of the conidiophore which bears one instead of several conidia.

PERONOSPORA BORRERIAE Lagerh.; Pat. & Lagerh. Bull. Soc. Myc. France **8**: 123. 1892

Like many of the other species of fungi which Professor Lagerheim collected in Ecuador the present one appears not to have been reported from additional localities. Nor is this the only point of interest in connection with this species, as it is neither a *Peronospora* in the strict sense of the word, nor does its host belong to the genus *Borreria*. Although the original description calls for dichotomously branched condiophores the specimen in the Ellis collection at the New York Botanical Garden shows only monopodially 4–5-times branched condiophores with the pronouncedly conic and narrowly pointed ultimate branchlets which are so characteristic of that section of the genus *Rhysotheca* which contains the species *R. Viburni*, *R. ribicola*, and *R. Gonolobi*. Indeed it approaches the last named species quite closely in both size and habit. The conidia are also nearest to those of that species, but their ovoid outline readily distinguishes them from those of any of the other species just mentioned. The present species should stand next to *R. Gonolobi*. An examination of the host shows it to be *Mitrocarpus hirsutus* (L.) DC., a species common throughout tropical America. We may, therefore, look for future collections of this fungus from other localities. The species should be known as **Rhysotheca Borreriae** (Lagerh.) G. W. Wilson.

RHYSOTHECA HELIOCARPA (Lagerh.) G. W. Wilson Bull. Torrey Club **34**: 402. 1907

This species was described by Lagerheim from Ecuador on *Heliocarpus*. So far as the present writer has been able to learn it has not been reported in any subsequent paper. It was with considerable pleasure and surprise that a packet of material from Cuba from the collections in 1903 by the late Professor L. M. Underwood and Professor Earle was examined and found to be this species. The material was collected at the base of El Yunque

Mt., Baracoa, during the month of March. The host is a species of *Triumfetta,* apparently *T. Lappula* L., a species which was also collected in the same region. The Cuban material is slightly more slender than the Ecuadorian, but is otherwise the same.

Pseudoperonospora Humuli (Miyabe & Takah.) nom. nov.

Peronoplasmopara Humuli Miyabe & Takah. Trans. Sapporo Nat. Hist. Soc. **1**: 153. 1907.

Pseudoperonospora Celtidis Humuli Davis, Science II. **31**: 753; (hyponym). 1910.

Plasmopara Humuli Miyabe & Takah. in Sacc. & Trott.; Sacc. Syll. Fung. **21**: 861. 1912.

This species first attracted attention by a serious outbreak in the hop-fields in the Province of Sapporo, Island of Hakkaido, Japan. It was later collected on the wild hops of the same island as well as on those of the Island of Honshu. Some years later Doctor Davis collected a fungus on the wild hops of Wisconsin which he considered quite close to *P. Celtidis,* but entitled to subspecific rank. Through the kindness of Mrs. Flora W. Patterson the writer has been able to examine Japanese material of this species and to compare it with specimens submitted by Doctor Davis. As in the case of *Kawakamia Cyperi* the measurements of the American material do not agree exactly with those of the Japanese specimens, but otherwise the similarity is too great to admit a question of their identity.

PERONOSPORA ERODII Fuckel. Fungi. Rhen. *2102.* 1867—Symb. Myc. 68. 1869

This species was issued by D. Saccardo in his Mycotheca Italica *890* as *Plasmopara Erodii* (Fuckel) D. Sacc. A note on the label states that in as much as the form on *Erodium* produces conidia which germinate by zoöspores it cannot be considered identical with *Peronospora conglomerata* Fuckel, on *Geranium,* to which European mycologists usually refer it. The correctness of this observation is further supported by the form of the conidia and the type of the conidiophores which indicate that the species is a member of the genus *Pseudoperonospora* and should be known as **Pseudoperonospora Erodii** (Fuckel) G. W. Wilson.

Bremiella gen. nov.[1]

Conidiophores from the stomata, the branches few and quite long, the main axis breaking up dichitomously or pseudo-monopodially, the ultimate branchelets quite long and terminating in an apophysate enlargement; conidia papillate, basially constricted and somewhat pyriform, hyaline, germinating by zoöspores: oöspores conspicuously wrinkled, free in the oogonium.

Type, *Peronospora megasperma* A. Berlese.

The downy-mildew of the violets of Europe and of America are two very distinct fungi which should never have been confused. *Peronospora Violae* De Bary is a typical member of the genus. The American form, which was first recognized as a distinct species in 1899 and named *Peronospora megasperma,* is such an anomalous form that the same author later transferred it to the genus *Plasmopara.*

Apparently the first collection of the American species was made in April 1882 by Professor F. S. Earle, who supplied material to Ellis for his North American Fungi. Of this material Doctor Farlow writes "The specimens received from Mr. Earle were collected in April 1883 (sic), and can be referred without doubt to this form their resemblance to *P. effusa* var. *minor*"[2] A note in a packet of this same collection in the Earle herbarium at the New York Botanical Garden calls attention to the swollen ends of the conidiophores and credits Professor Burrill with having pointed out the essential differences which we have noted between this and the European species. Upon the same authority the conidia are also said to germinate by means of zoöspores. The conflicting evidence leaves it an open question whether or not both of the violet-inhabiting species occur in America. It appears, however, from an examination of the material at hand that in all probability we have in America only one species. This we have designated **Bremiella megasperma** (A. Berlese) G. W. Wilson.

[1] Hyphis conidiophoris solitaris vel fasciculatis, e stomatibus plantarum erumpentibus, dichotomo-vel pseudo-monopodio-ramosis; ramuli terminalis longis, apice in vesiculam apophysatam abientibus; conidis hyalinis, pyriformibus, apice papillatis, per zoosporas evacuantia; oosporis subrugosis.

[2] Bot. Gaz. **8**: 328. 1883.

PERONOSPORA DESTRUCTOR (Berk.) Casp.; Berk. Outl. Brit. Fung. 349. 1860

Botrytis destructor Berk. Ann. Mag. Nat. Hist. II. **6**: 436. 1841.
Peronospora Schleideni Unger, Bot. Zeit. **5**: 315. 1847.
Peronospora Schleideniana Unger: De Bary, Ann. Sci. Nat. IV. **20**: 122. 1863.

The synonymy of this species has been discussed briefly by Professor Whetzel,[3] but as this author retains the last name in preference to the first it may not be out of place to again call attention to the nomenclatural vicissitudes of the species. First described by Berkeley as *Botrytis destructor* the same author later lists it under *Peronospora,* citing the earlier synonym, and crediting the combination to Caspary, probably in recognition of some manuscript name. Meantime Schleiden found the same species in Germany and figured it with a brief description, calling it *Botrytis (parasitica?)*[4] This forms the basis of *Peronospora Schleideni* Unger, which was later amended to *P. Schleideniani* in De Bary's revision of the group. While the weight of this authority has given the latter name wide usage, the older one is the proper designation of the species.

PERONOSPORA ARENARIAE MACROSPORA Farl. Bot. Gaz. **9**: 38. 1884. Not *Peronospora macrospora* Unger. 1847

Of the six species of *Peronospora* which infest members of the pink family three have tuberculate oöspores. Two of these species are European, *P. Dianthia* De Bary being found on species of *Dianthus, Agrostemma,* and *Lychnis* and *P. Arenariae* De Bary on *Arenaria* and related genera, while the third is an American species on *Silene.* In 1884 Professor Farlow first called attention to the American species, pointing out its intermediate position between the two European species just mentioned and giving it a varietal position under the later of these. An examination of American material and a comparison with both of the foreign species has convinced the writer that the form under consideration is entitled to specific rank. While the oöspores are larger than those of *P. Arenariae* they are otherwise quite similar. The

[3] Bull. Cornell Agr. Exp. Sta. 218: 149. 1904.

[4] Grundz. Wiss. Bot., ed. 3, **2**: 37. *f. 106.* 1849.

conidiophores are also more like those of *P. Arenariae*, but suggesting somewhat *P. Dianthi*. This last species, however, is somewhat stouter than the others. The conidiophore of the American species is somewhat more branched than *P. Arenariae* and has much more slender ultimate branchlets than does the European species. As the varietal name is untenable for a species in the genus this fungus may be renamed **Peronospora Silenes** G. W. Wilson.

PERONOSPORA PARASITICA (Pers.) Fries AND ITS SEGREGATES

While it has been customary to consider any collection of *Peronospora* on a Cruciferous host as certainly belonging to *P. parasitica* a very wide range of variation has been allowed in the characterization of the species. True, various names have been applied, especially by the earlier authors, to the fungus as it appears on various hosts. The majority of these names, however, represent what may be termed "host species," *i. e.*, their chief distinguishing characteristic is their host.

The first valid segregation by an European mycologist was based on an error in the determination of the host. The case in point is *P. Niessleana* A. Berlese, based on a specimen in the herbarium of Niessl which was labeled *P. Phyteumis* Fuckel, on *Phyteuma*, but evidently not that species. So thoroughly convinced does this author appear to have been that the fungus in question was distinct from other recognized species that when it was found that the host was in reality *Alliaria* he retained the form as a subspecies under *P. parasitica*. What appears to be the same species of fungus was figured by Sowerby as *Mucor Erysimi*. Berlese's first judgment was better than his last, as the form is certainly entitled to specific rank.

A careful study of a wide range of specimens has convinced the writer that there is still a third form on the Cruciferae which deserves to be accorded specific rank. The more comprehensive of the published descriptions have recognized a form of *P. parasitica* with comparatively simple conidiophores which have a more open head. This form is quite widespread in America, and from the literature it appears to be common in Europe. A subspecies

has been described from Australia by McAlpine as *P. parasitica Lepidii,* which is based upon essentially the same set of characters. Through the courtesy of Professor McAlpine the writer has been enabled to examine cotype material of the Australian fungus which proves to be in every way identical with the American form.

The synonymy of these species and a description of the third one follows. No account is taken here of *P. crispula* Fuckel, on *Reseda* in Europe, which has frequently been referred as a synonym to *P. parasitica,* but which is certainly to be regarded as a valid species.

1. PERONOSPORA PARASITICA (Pers.) Fries, Sum. Veg. Scand. 493. 1849

Botrytis parasitica Pers. Obs. Myc. **1**: 96. 1796.

Mucor Botrytis Sow. Eng. Fungi *pl. 359.* 1802.

Botrytis nivea Mart. Fl. Crypt. Erlang. 342. 1817.

Peronospora ochroleuca Ces. in Rab. Herb. Viv. Myc. II: *175.* 1855.

Peronospora Dentariae Rab. Fungi Europ. *86*—Flora **42**: 436. 1859.

Peronospora Botrytis Cocconi & Morini, Mem. Acad. Sci. Ist. Bologna IV. **6**: 394. 1885.

2. PERONOSPORA NIESSLEANA A. Berlese, Icon. Fung. Phyc. 40. *pl. 66, f. 1.* 1898

?*Mucor Erysimi* Sow. Eng. Fungi *pl. 400, f. 7.* 1803.

Peronospora parisitica Niessleana A. Berlese, Icon. Fungi Phyc. 41. 1898.

3. **Peronospora Lepidii** (McAlp.) sp. nov.

Peronospora parasitica Lepidii McAlp. Proc. Royal Soc. Victoria **7**: 221. 1895.

Hypophyllous or caulicolous, covering the irregular and more or less indefinite infected area with a dense white growth; conidiophores 3–8 from a stoma, $130–223 \times 4–9\,\mu$, 3–8 times branched, the primary branches erect, the ultimate branchlets straight or somewhat recurved, arising at acute angles, about $3 \times 8\,\mu$; conidia broadly ellipsoid or almost globose, $15–23 \times 18–35\,\mu$, hyaline; oögo-

nia with a thick, yellowish membrane which does not collapse; oöspores subglobose, 25–50 μ, epispore yellowish-brown, wrinkled.[5]

ON BRASSICACEAE:

Arabis virginica (L.) Trel., Alabama, *Underwood.*

Bursa Bursa-pastoris (L.) Britton, Kentucky, *Kellerman.*

Coronopus didyma (L.) J. E. Smith, North Carolina, *Wilson.*

Lepidium apetalum Willd., Iowa, *Wilson;* Nebraska, *Sheldon.*

Lepidium Virginicum L., Illinois, *Seymour* (Econ. Fungi *258a*); Kansas *Bartholomew* (Fungi Columb. *2129*); Kentucky, *Kellerman* (Fungi Europ. *2870*, N. Am. Fungi *1460b*); New Jersey, *Halsted* (Econ. Fungi *258b*); North Carolina, *Stevens.*

Lepidium sp., Idaho, A. A. & E. G. Heller, *3020.*

Roripa palustris (DC.) Bessey, Iowa, *Hitchcock.*

Roripa sp., Alabama, *Underwood.*

Sophia sp., Colorado, *Bethel.*

DISTRIBUTION: New Jersey to Alabama and Colorado. Also in Australia, and probably in Europe.

TYPE LOCALITY: Ardmona, Victoria, Australia, on *Lepidium ruderale* L.

The three species on Cruciferous hosts may be briefly characterized as follows: *P. parasitica,* with much branched conidiophores, the branches forming a dense tangled head, *P. Niessleana* having an open headed conidiophore which branches 2–4 times, the branches widely spreading and with the extremities rather recurved, *P. Lepidii* with the main branches of the conidiophore ascending, but not forming a dense head as in *P. parasitica.*

PERONOSPORA SCHACHTII Fuckel, Fungi Rhen. *1508*—Symb. Myc. 71. 1869

This species, which is readily distinguished from the others which inhabit Chenopodiaceous hosts by the straight branches of

[5] Hypophyllis vel caulicolis, caespitulis densis, albis; conidiophoris 3–8 fasciculatis, 130–223 × 4–9 μ, 3–8-ies ramosis, ramis inferioribus rectis, angulato-divergentibus, penultimis et ultimis subulatis, acutangulo-divergentibus, rectis vel saepius recurvatis, subaequalibus, circa 3 × 8 μ; conidiis late ellipticis vel fere globosis, 15–22 × 18–35 μ, hyalinis; ooginis e tunica crassa, pallide-lutea, persistenti formatis 35–60 μ; oosporis subglobosis, 25–50 μ, episporis luteo-bruneis, rugosis.

its conidiophores, has recently appeared on the sugar beet in California. So far as recorded the species appears to be known only on cultivated beets, except in Portugal where Professor Lagerheim found it on the wild *Beta marina*. Fortunately from the agricultural standpoint the fungus does not seem to thrive as well in our climate as have some other imported forms. It is to be hoped that it may not prove a serious pest here.

PERONOSPORA EFFUSA (Grev.) Ces.

This name has been applied very loosely to various members of the genus *Peronospora* from hosts of several widely separated families, but in recent years the name has been restricted to the *Peronospora* on Chenopodiaceous hosts other than the genus *Beta*. Two forms of *P. effusa* are usually recognized by mycologists, but there is such wide diversity in the application of the names that the material referred to var. *minor* by one author is called var. *major* by another. While the taxonomic history of the species is not long in list of names the earlier descriptions were drawn up at a time when "brevity was indeed the soul of wit."

The description of *Botrytis effusa* Grev. is accepted as the starting point of the history of the species. This name was proposed for a parasite of *Spinicia oleracea* in Scotland. The fungus was figured a few years later by Desmaziers[6] who represents the divaricate form on spinage. He also adds *Atriplex, Chenopodium, Urtica* and *Rhinanthus* to the list of hosts and makes a query as to whether or not *B. effusa* Grev. and *B. farinosa* Fries are identical. The latter species is evidently rather closely related to the former which is not mentioned by Fries. The type of *B. farinosa* came from leaves of *Atriplex*, but older saprophytic species are cited as synonyms.. From the descriptions of these two species of *Botrytis* we may feel sure that the first refers to the *Peronospora* on *Spinicia* and the second to that on *Atriplex*.

The species were transferred to *Peronospora* by Cesati and within a few years other names were added to the synonymy of the species. Schlechtendal had just previously described a species on *Chenopodium hybridum* which he called *Peronospora Chenopodii*. While his description is very indefinite, his material is quite

[6] Ann. Sci. Nat. II. 8: *pl. 1. f. 1, 2.* 1837.

unlike that figured by Desmazières, having flexuose branches with the ultimate branchlets strongly recurved. That is to say, if we adopt the classification proposed by Berlese the material of Greville and Desmazières would fall in the section *intermediate* while that described by Schlechtendal belongs to *divaricatae*. That *Peronospora effusa* presented a wide range of variation was first pointed out by Caspary[7] who recognized two varieties, *α major* being the typical intermediate form of the older authors, while *β minor* on *Atriplex patula* from Bonn is the undulate form..

Recently Laubert[8] discussed the variations within the accepted limits of the species and figured portions of the conidiophores of the two forms. He does not refer to the synonymy of the species nor propose any new name for either form. In the course of the review of this article Detmann removes the typical portion of the species from *Peronospora effusa* and calls it *P. Spinaciae* n. sp.

The most recent pronouncement on the question comes as an echo from the Brussels congress where the assembled botanists of the world in their wisdom decreed that those fungi not otherwise provided for should begin their historical career with Fries's Systema. As this work contains the reference noted above to *Botrytis farinosa* and its saphrophytic habits but does not mention the earleir better defined and strictly parasitic *Botrytis effusa*, Doctor Keissler concludes that it is necessary to take up *Botrytis farinosa* and drop *P. effusa* to the realm of prehistoric nomenclature. He accordingly transfers the name to *Peronospora*, cites the stock synonyms, and then issues in "Kryptogamae exsiccatae" *1829* two specimens, "*a*) Austria inferior: ad folia *Chenopodii albi* L. . . . *b*) Hungaria: ad folio *Chenopodii hybridi* L. . . ." The first of these is *P. farinosa* as treated in the present paper, while the second belongs to the other side of the species.

A careful study of these forms leads to the conclusion that as usually construed *Peronospora effusa* consists of two quite dissimilar species. The complete synonymy as well as the list of hosts from which material was studied follows.

[7] Rab. herb. Viv. Myc. II. cent. *2*. *172*. 1855.

[8] Gartenflora **55**: 433–440. *f. 45*. 1906.

1. PERONOSPORA EFFUSA (Grev.) Ces. in Rab. Herb. Viv. Myc. I. *1880.* 1854

Botrytis effusa Grev. Fl. Edin. 468. 1824.
Peronospora effusa α major Casp. Monatsb. K. Preuss. Akad. Wiss. **1855**: 328. 1855.
Peronospora Spinaciae Detmann, Bot. Cent. **105**: 25. 1907.

HOSTS: **America,** *Chenopodium album, C. hybridum, Monolepis Nuttalliana, Spinicia oleracea.* **Europe,** *Chenopodium polyspermum, C. hybridum, Spinacia oleracea.*

Most abundant on *Spinacea oleracea.*

2. PERONOSPORA FARINOSA (Fries) Keissler, Ann. K. K. Naturh. Hofm. Wein **25**: 229. 1911

Botrytis farinosa Fries, Symb. Myc. **3**: 404. (Excl. synonymy.) 1823.
Erineum atriplicinum Nestler; Fée, Mem. Phyll. et Erineum 59. 1834.
Peronospora Chenopodii Schlecht. Bot. Zeit. **10**: 619. 1852.
Monosporium Chenopodii Schlecht. Bot. Zeit. **10**: 619. 1852.
?*Peronospora Chenopodii* Casp. Bot. Zeit. **12**: 565. 1854.
Peronospora effusa β minor Casp.; Rab. Herb. Viv. II. *172.* 1855.
Peronospora epiphylla Pat. & Lagerh. Bull. Soc. Myc. France **7**: 167. p. p. 1891.

HOSTS: **America,** *Chenopodium album, C. hybridum, C. leptospermum.* **Europe,** *Atriplex patulla, Chenopodium album, C. Bonus-Henricus, C. glaucum, C. hybridum, C. Murale, C. rubrum, Spinacia oleracea.* **Asia,** *Chenopodium album.*

Most abundant on species of *Chenopodium* and *Atriplex.*

SPECIES OF PERONOSPORA WHICH INFEST EUPHORBIACEAE

Four species of *Peronospora* have been described from hosts of the family Euphorbiaceae. The first of these was *P. Pepli* Durieu[9] which was found in France on *Euphorbia Peplis* L. While the author does not give a formal description of his plant he speaks of the conidiophores in a way to bear out his statement

[9] Ann. Soc. Linn. Bordeaux **20**: — (13). 1855.

that the fungus is similar to *Botrytis parasitica.* It would appear that he had a species of *Peronospora,* but it is impossible to say which one without seeing material of his collection. In the course of his remarks he refers to the remarkable phenomenon of the same plants also harboring a species of *Erysiphe,* and, to judge from the comments of his contemporaries, the material which he disturbed among them contained only the later fungus.

In 1863 Fuckel issued in his Fungi Rhen. *40* a *Peronospora* on *Euphorbia platyphylla,* naming it *P. Euphorbiae,* and in his monograph of the same year De Bary described another species from *Euphorbia Syparissias* as *P. Cyparissiae.*[10] Through the kindness of Doctor Tranzschel it has been possible to examine material from Fuckel's exsiccati. A comparison of this with authentic material of *P. Cyparissiae* shows them to be distinct from each other as well as from the species to be mentioned later. *P. Euphorbiae* has hyaline conidia, while *P. Cyparissiae* has violet ones. *P. Euporbiae* has slender conidiophores which are 6–8 times branches, the ultimate branchlets rather widely divergent, the branches straightish, and forming a rather close head. *P. Cyparissiae* has a stouter conidiophore with more erect habit, and a closer head, the ultimate branchlets also widely divergent. As the oöspores of *P. Cpyarissiae* are unknown no comparison on this point can be made.

The next species to be described was *P. andina* Speg.[11] from Argentina, which is much smaller than the preceding. The conidiophores are rather small, branching 3–5 times, the branches spreading, the ultimate branchlets rather flexuose, and forming an open head. The conidia are hyaline. The oöspores are unknown.

The North American species of *Peronospora* on hosts of this family has been variously recorded as *P. Euphorbiae* and *P. Cyparissiae.* A close study of the American fungus and a comparison with these European species shows it to differ in several respects from either of them. As our species has violet conidia we can dismiss *P. Euphorbiae* with the remark that its oöspores are more wrinkled than those of our species. Its conidia, while of the same color as those of *P. Cyparissiae* are slightly more

[10] Ann. Sci. Nat. IV. **20**: 124.

[11] Ann. Mus. Nac. Buenos Aires III. **12**: 282. *f. 3.* 1909.

rounded, while the conidiophores present still more marked contrasts. In the American species the conidiophores are more branched than in either of the European species, the branches are rather flexuose and incurved, forming a denser head than in either of these species. In our species, the conidiophore branches are more slender and the ultimate branchlets longer than in the European. As this series of differences is sufficient to warrant the separation of our form as a distinct species, a diagnosis follows, under the name *Peronospora Chamaesycis,* as all its hosts belong to this segregate of Euphorbia.

Peronospora Chamaesycis sp. nov.

Hypophyllous, forming a dense bluish felt-like growth on the host, epiphyllous discoloration not prominent, rather chloratic or somewhat yellowish; conidiophores solitary or only two or three from a stoma, $200–450 \times 6–10\,\mu$, branching 6–9 times, the branches elongate, slender, more or less flaccid, and having a tendency to be incurved, more or less flexuose, the ultimate branchlets at right angles, subequal, the axial longer, somewhat subulate, slender, straight, $5–8 \times 2–4\,\mu$; conidia globose to ovoid, $20–28 \times 12–20\,\mu$, violet; oögonia thin walled, yellowish; oöspores $30–40\,\mu$, yellowish-brown, epispore smoothish or more or less wrinkled.[12]

Type, on *Chamaesyce serpens* (H.B.K.) Small, Rooks County, Kansas, E. Bartholemew, Aug. 25, 1902. Issued as Fungi Columbiana *1750*, in the herbarium of the New York Botanical Garden.

ON EUPHORBIACEAE:

Chamaesyce glyptosperum (Engelm.) Small (*Euphorbia glyptosperum* Engelm.), Nebraska, *Bates* (Fungi Columb. *2338*).

Chamaesyce humistrata (Engelm.) Small (*Euphorbia humistrata* Engelm.), Indiana, *Wilson.*

Chamaesyce maculata (L.) Small (*Euphorbia maculata* L.), Illinois, *Conkling;* Indiana, *Arthur Wilson;* Iowa, *Hitchcock, Wilson;* Massachusetts, *Farlow* (N. Am. Fungi *216*); New Jersey, *Ellis.*

[12] Maculis epiphyllis decoloratis, griseo- vel diluto-aureiis; conidiophoris hypophyllis, dense caespitosis, 1–3 e stomatibus erumpentis, $200–450 \times 6–10\,\mu$, 6–9-ies ramosis, ramis elongatis, gracilibus, flaccidis, incurvatus, flexuosis, ultimis subequalibus, axilibus longiore, subulatis, rectis, $5–8 \times 2–4\,\mu$; conideis globosis vel ovoideis, $20–28 \times 12–20\,\mu$, violaciis; oogoniis auriis; oosporis $30–40\,\mu$, aureo-bruneis, episporeis crassis.

Chamaesyce serpens (H.B.K.) Small (*Euphorbia serpens* H.B.K.), Kansas, *Bartholomew* (Fungi Columb. *1750*).

Chymaesyce stictospora (Engelm.) Small (*Euphorbia stictospora* Engelm.), Nebraska, *Bates* (Fungi Columb. *2128*).

DISTRIBUTION: Throughout the northeastern United States.

PERONOSPORA TRIFOLIORUM De Bary, Ann. Sci. Nat. IV. **20**: 117. 1863

This species, which has been known in America until recent years as most abundant on certain species of *Astragalus*, has appeared on alfalfa (*Medicago sativa*) in numerous localities from New York to California. In some localities it appears to be of rather slight economic importance, while in others it is reported to cause serious trouble. To judge from the specimens available for study the form on *Medicago* is slightly more slender than that on *Trifolium*, and several times as abundant, even in Europe, on that host as on all the various species of *Trifolium* together. It would appear that the species is made up of races only slightly different from each other morphologically, but with unequal virulence.

PERONOSPORA PLANTAGINIS Underw. Bull. Torrey Club **24**: 83. 1897

This is a quite different species from the older and better known *P. alta* Fuckel, which is common in the northern states on *Plantago major* and other broad-leaved perennial species of the genus. The conidiophores of *P. Plantaginis* are a trifle stouter, with a smaller head, and straighter branches, with the ultimate branchlets much smaller. The conidia are also shorter and not so blunt as in *P. alta*. This species is found on *Plantago aristata* from North Carolina to Alabama. In the region of Raleigh, North Carolina, where the writer had the opportunity of studying the fungus in the field it was very abundant, sometimes appearing to be quite injurious to its host.

The oöspores of neither *P. Plantaginis* nor *P. alta* have been described. It is consequently a matter for regret that the specimen on *Plantago pusilla* from Alabama in the Ellis collection has no conidiophores so that the species of *Peronospora* could be de-

termined, as oöspores are present in abundance. They very evidently belong to a species of *Peronospora,* rather than to a Chytridiaceous fungus. They are yellowish-brown, quite large, measuring 60–95 μ across, and have a conspicuously wrinkled epispore.

PERONOSPORA PHLOGINA Dietel & Holway, Bot. Gaz. **19**: 306. 1894

Two species of *Peronospora* have been described from hosts of the family Polemoniaceae. The first of these, *P. Phlogina,* was described from material collected by Professor Holway at Decorah, Iowa, on *Phlox divaricata.* The next year *P. Giliae* Ellis & Ev.[13] was described from northern Idaho on an undetermined species of *Gilia.* Such is the uncertainty of matters taxonomic that the host is no longer considered to belong to that genus, but to one of the recent segregates. It accordingly bears the name *Microsteris gracilis* (Dougl.) Greene. While the two species of fungi have found their way into separate sections of the genus *Peronospora* in Berlese's monograph they agree in all essential details. The conidiophores are of the same type, the conidia present less variation than do those of some species of the genus, and all together there does not appear to be more variation than can reasonably be expected in a species, especially one so poorly known. These species, therefore, must be united under the older name.

PERONOSPORA POTENTILLAE De Bary, AND ITS SEGREGATES

While various species of *Peronospora* have been described on widely separated genera of Rosaceae they have, with the exception of *P. sparsa* Berk. on species of *Rosa,* at one time or another been referred to *P. Potentillae.* Three of these species are present in America, and it is with these that we are at present concerned. *Peronospora Potentillae* De Bary, the older of these species, was originally described from material on a species of *Potentilla.* As further collections were made it was found to be prevalent on several other genera of herbaceous Rosaceae. Later two French botanists, Roze and Cornu, described *Peronospora Fragariæ.*[14]

[13] Cont. U. S. Nat. Herb. **3**: 276. 1895.
[14] Bull. Soc. Bot. France **23**: 242. 1876.

from *Fragaria vesca* in France. This is a very large species, the conidiophores reaching the rather startling height of a millimeter, and branching more profusely than do those of other species on Rosaceous hosts. The conidia, as might be expected, average a little larger also. As the leaves of *Fragaria* and certain species of *Potentilla* which are infected with the fungus are not sufficiently different either in texture or hairiness to account for the wide variation between the fungi on them we are led to conclude that they represent two valid species.

The third species with which we are concerned, *P. Rubi Rab.*[15] was distributed by Rabenhorst on *Rubus fruticosus* from Germany. In the *Rubus*-inhabiting fungus the conidia and conidiophores are nearer the same size as those of *P. Potentillae* than is the case with *P. Fragariae*. However, the two species, similar as they are, are quite readily distinguishable. *P. Rubi* has conidiophores more branched, with longer ultimate branchlets, and a denser head, while the conidia are somewhat broader and darker in color than those of *P. Potentillae*.

From the foregoing comparison we conclude that there are in America three species of *Peronospora* on Rosaceous hosts. These are *P. Rubi* Rab. confined to the shrubby genus *Rubus, P. Fragariae* Roze & Cornu, collected in Iowa on *Fragaria,* and *P. Potentillae* De Bary on various species of *Agrimonia, Geum,* and *Potentilla.* Besides these *P. sparsa* Berk. is found occasionally on *Rosa.*

PERONOSPORA ARTHURI Farlow, Bot. Gaz. **8**: 315. 1883

This species, which appears to be rather widespread and somewhat sporadic in its appearance, presents an interesting puzzle to those who follow Schröter and Fischer in dividing the species of *Peronospora* into two groups on the basis of oöspore markings, placing in Calotheca all those species which have reticulate or tuberculate oöspores and in Leiotheca those having smooth or wrinkled oöspores. In the present species the oöspores possess pronounced characters of both these groups, as the epispore is conspicuously wrinkled, and thickly covered with short blunt tubercles.

[15] Fungi Europ. *2676* (hyponym) 1881.—Schröt. in Cohn, Krypt. Fl. Schles. 3^1: 250. 1886.

PERONOSPORA TRICHOMATA Massee, Jour. Linn. Soc. **24**: 48. *pl. 1, f. 1.* 1887

The species so designated is described as causing a serious root-rot disease of *Colocasia esculenta* in Jamaica. This subterranean habit is at variance with the usual place of growth of members of this family, all of which are leaf parasites, or at least grow on the aerial parts of the host. The author's figures are not convincing that the fungus in question has been properly referred. It would appear from them that the conidial part of the species belongs to some genus of Hyphomycetes, probably *Verticillium,* and that the oösporic phase belongs elsewhere in the same group. A careful study of material from the herbarium of Professor Massee confirms this view. The species, then, is to be excluded from the genus *Peronospora* and transferred to the Hyphomycetes. As *Phytophora Colocasiae* Rac. is now known to cause a tuber rot in India it is not improbable that this species was the real offender, while the fungi described may have been merely secondary saprophytes.

It is not impossible that the material submitted to Massee was affected by *Phytophthora Colocasiae* Racib., and that this fungus was overgrown by those which he described.

PERONOSPORA NICOTIANAE Speg.

From time to time various alarmist reports have appeared as to the dire consequences of the spread of either the present species or *Phytophthora Nicotianae* Van Breda de Haan into tobacco growing countries other than their native lands. It is accordingly cause for some little surprise that mycologists have so far failed in the majority of cases where they have come in contact with this species to recognize it as the dreaded foe for which they were looking. The history of the species was given in brief in so far as it referred to certain hosts, in a former number of this series.[16] In addition to the cases mentioned in that paper two others deserve mention. Harkness and Moore have recorded *Peronospora sordida* on *Nicotiana Bigelovii* from Nevada. This, with the record by Professor Farlow of *P. Hyoscyami* on *N. glauca* in California, would indicate that *P. Nicotianae* was probably not a formidable

[16] Bull. Torrey Club **35**: 364. 1908.

foe to the American tobacco grower. However evidence comes from a different quarter which is not so quieting. For a term of years serious outbreaks of a seed-bed disease of tobacco plants in Australia caused much loss to the tobacco growers of the colony of Victoria. Material submitted to Professor Massee for identification was pronounced *P. sordida* Berk. a very different species which is confined to certain genera of Scrophulariaceae. However this Australian record is the only one of the species being found on *Nicotiana Tabacum*.

Peronospora minima sp. nov.[17]

Hypophyllous, forming an irregularly distributed grayish growth over the entire under surface of the leaf, epiphyllous discoloration apparently merely chlorotic; conidiophores straight or slightly flexuose, 2–10 from a stoma, short and little branched, $150–300 \times 8–10\,\mu$, branching 1–3 or 4 times, the branches straight, ultimate branchlets at acute angles, axial scarcely deflected, sometimes ultimate branchlets arise in groups of three, conic, $15–20 \times 4–6\,\mu$, occasionally the conidiophore is reduced and bears only 3 or 4 conidia-bearing branchlets; conidia globose, very light yellowish-brown, $28–32\,\mu$; oöspores subglobose, $65–80\,\mu$, epispore yellowish, wrinkled rather conspicuously; oögonium rather thick walled, slightly larger than the oöspore, somewhat flattened.

Type, in herbarium Wilson, collected by G. Lagerheim at Tromsö, Norway, on *Saxifraga cernua* L., Aug. 1895.

This is the smallest species of the genus and stands out sharply not only from the other species on Saxifragaceae all of which are considerably larger and better developed, but from the species which it appears to approach closest as well. In size and method of branching of the conidiophores it approaches nearest to *P. violacea* Berk., while the globose conidia might suggest a relationship to some of the larger species such as *P. Phyteumatis* Fuckel.

[17] Hypophyllis, conidiophoris densis caespitosis, griseis; conidiophoris rectis vel flexuosis, 2–10-fasciculatis, brevis, pauci ramosis, $150–300 \times 8–10\,\mu$, 1–3 vel 4-ies ramosis, ramis rectis, ultimis conicis, $15–20 \times 4–6\,\mu$, vel conidiophoris minimis, cum 3–4 conidiis; conidiis globosis, diluto-aureo-bruneis, $28–32\,\mu$; oosporis auriis, diam., $65–80\,\mu$.

EXPLANATION OF PLATES CXXXV AND CXXXVI

Plate 135. *Peronospora Lepidii* and *P. Chamaesycis*

Figs. 1–10. *Peronospora Lepidii.* (Figs. 1–7 on *Lepidium virginicum* from Kentucky—N. Am. Fungi *1406b.*—Figs. 8–19 on *L. ruderale,* from Victoria, Australia.)

Figs. 1–5. Conidiophores of the American specimens.
Fig. 6. Two conidia from the same specimen.
Fig. 7. Group of oöspores from the same specimen.
Figs. 8, 9. Conidiophores of the Australian specimen.
Fig. 10. Two conidia from the same specimen.

Figs. 11–13. *Peronospora Chamaesycis.* (On *Chamaesyce serpens* from Kansas—Fungi Columb. *1750.*)

Fig. 11. Conidiophore.
Fig. 12. Group of conidia.
Fig. 13. Two oöspores.

Plate 136. *Peronospora* on *Saxifragaceae*

Figs. 14, 15. *Peronospora Chrysosplenii.* (On *Chrysosplenium alternifolia* from Bohemia.—Sydow Phyc. Prot. *202.*)

Fig. 14. Conidiophores.
Fig. 15. Conidia.

Figs. 16, 17. *Peronospora Saxifragae.* (On *Saxifraga granulata* from Bohemia.—Sydow Phyc. Prot. *220.*)

Fig. 16. Conidiophore.
Fig. 17. Conidia.

Figs. 18–22. *Peronospora minima.* (On *Saxifraga cernua* from Norway.)

Figs. 18–20. Conidiophores.
Fig. 21. Group of conidia.
Fig. 22. Two oöspores.

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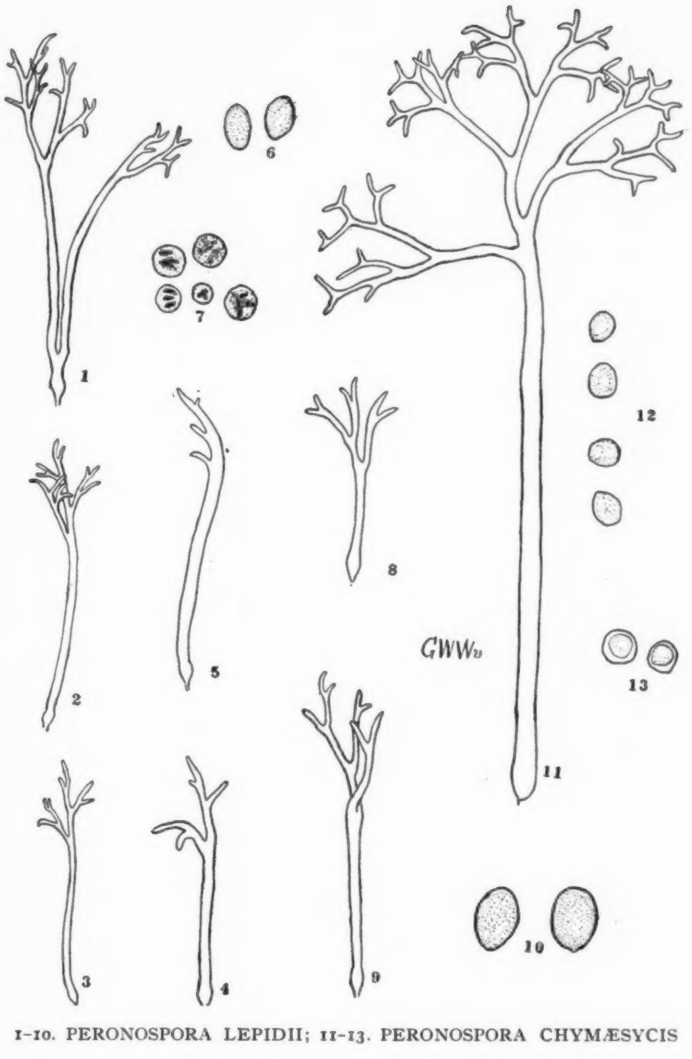
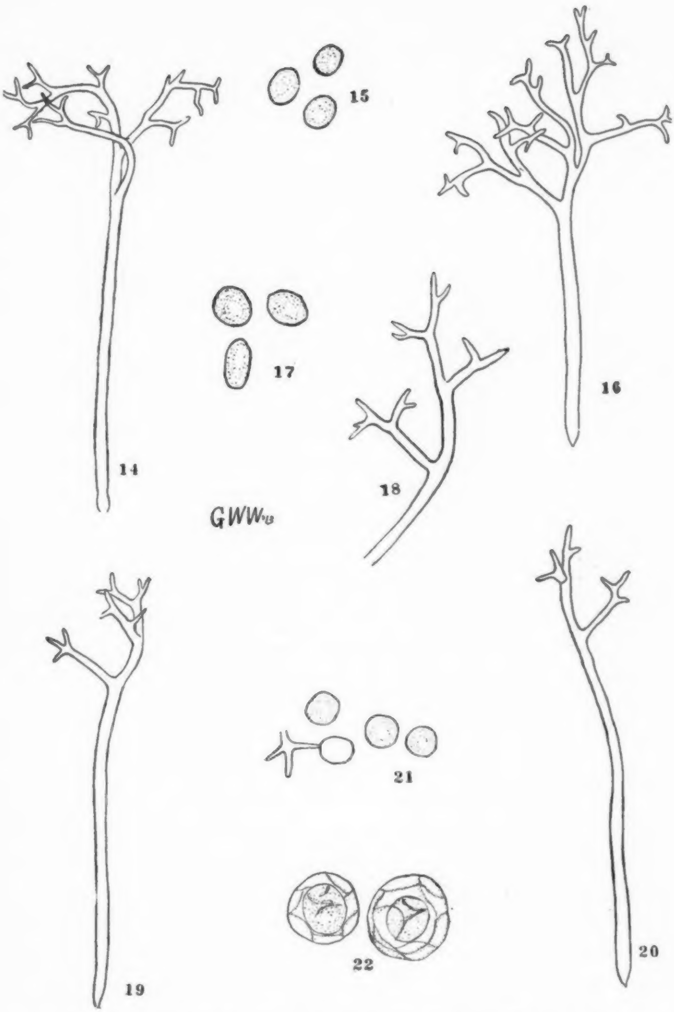


1–10. PERONOSPORA LEPIDII; 11–13. PERONOSPORA CHYMÆSYCIS



14, 15. PERONOSPORA CHRYSOSPLENI; 16, 17. PERONOSPORA SAXIFRAGÆ; 18–22. PERONOSPORA MINIMA

CONIDIUM PRODUCTION IN PENICILLIUM[1]

CHARLES THOM

Certain morphological features are common to the species which for convenience are lumped together under the generic name, *Penicillium*.

CONIDIOPHORES

The fertile hyphae or conidiophores may arise as branches from submerged or from aerial hyphae. They are septate except when they are very short. They have approximately the same diameter as the vegetative hyphae from which they branch. They are uniform in diameter from point of origin to the point where the conidium-producing complex of cells begins to form. The apex of the uppermost cell is frequently though not always swollen somewhat like the vesicle of *Aspergillus,* and the distal ends of branches if such are present are commonly also swollen, but the appearance of such swelling is not a uniform character within the species. The conidiophore proper should be measured from the point of origin to the base of the fruiting group of cells or branches. This part ceases to grow in length when fruiting commences, hence this measurement is more characteristic than a measurement including fruiting mass which frequently increases in length for several weeks by the production of new conidia.

CONIDIAL APPARATUS[2]

The essential organ of conidium production in this group is the fertile cell which has been differently named by various workers as a basidium by Brefeld, Stoll, the writer in part, as sterigma, by Westling, Bainier, Wehmer, and others. The term "conidiiferous cell" was used in the English descriptions of writer's previous paper because the word had no morphological significance in

1 Published by permission of the Secretary of Agriculture.

2 This section of the paper was presented to the Botanical Society of America at Washington, D. C., December 27, 1911, under the title "The Connective between Conidia of *Penicillium*," with an abstract appearing in Science, N. S., vol. 35, no. 891, January 26, 1912, pp. 149–150.

other groups. The use of these terms has been fully discussed by Westling[3] who prefers the term sterigma. These fertile cells are uninucleate, tubular rather than flaskshaped. While not uniform in diameter such swelling as is found is usually about the middle of the length. The variations in shape are such as may be easily attributed to the effect of crowding many such cells into compact verticils upon the dome-like apex of the fertile branch. The diameter of the cell is usually a little less than that of the branch below it. The tubular form with an average diameter is maintained to a length varying somewhat but fairly characteristic for each species. There is, then, a more or less abrupt reduction to a smaller tube (figure a), from which the conidia arise. This tube may be found to vary within the field of the microscope from imperceptible to several microns in length.

CONIDIUM FORMATION

The process of conidium formation as far as it has been followed cytologically, involves the division of the cell nucleus, the migration of one of the daughter nuclei to the tip of the tube which grows rapidly in length, the formation of a cross-wall in the tube at a distance from the tip characteristic for the species, and the swelling of the new conidium to the size and shape typical for the species. Some preparations give no hint of this process. If conidium formation be for some reason arrested, the newest conidium may rest directly upon the basal cell without a vestige of a tube between. In other cases, a tube several microns long may separate the conidium from the main body of the parent cell. Every gradation may be found in the same culture if it is watched over a period of several days to several weeks. No species has shown conidia globose from the first. Such appearances may be easily found but examination of fresher or younger colonies shows them to be misleading. However quickly the stage may pass, the conidium of Penicillium arises as a cylindrical or barrel-shaped segment cut by cross-wall from the end of the fertile tube of the conidiiferous cell. This tube was designated by the writer in a previous paper as the sterigma because of its really permanent character as a conidium-forming organ of the cell. One might reasonably designate it a character of the genus.

[3] Westling, R., Arkiv. f. Bot. Bd. II (1911), no. 1, pp. 1–156.

CONNECTIVE

Once formed, the conidium reaches characteristic form and size by swelling and laying down new walls for itself within the primary wall which is continuous with that of the parent cell. The appearance of a connective (bridge, or disjunctor) is due to this old wall. The presence of this connective is figured by various authors and noted as common, but without explanation by Westling. The appearance arises in certain species[4] and especially in particular media from the swelling and rounding up of the new cell within the old wall. Such formation is more frequent in

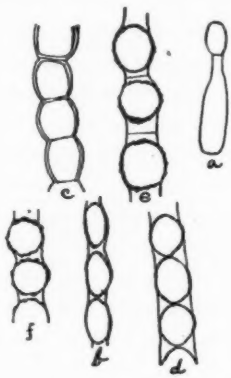


FIG. 1. Conidium formation and the connective in *Penicillium*: *a*, conidium-bearing cell showing the tube and a conidium in its elliptical stage; *b*, *d*, *f*, chains of conidia showing different appearances of the connective but no cross-walls; *c*, *e*, chains of conidia in which the original cross-wall shows.

media poor in nutrients especially in carbohydrates. In such cases the new wall following the plasma membrane, splits away from the old at the ends of the cell leaving an apparently empty space bridged across by the lines made by the primary wall. In especially favorable cases the original cross wall can be traced. Commonly the cells remain in contact with the center of the cross-wall where doubtless protoplasmic connections from cell to cell are continued for some time. In many cases, interpretation of the appearance would be impossible unless the true arrangement of walls had been traced out in these favorable forms.

[4] These statements are equally true for all species of Aspergillus examined by the writer.

In preparations which show no connective the explanation is equally simple, the primary wall adheres to the new or secondary wall, and takes the shape of the new cell. In some species conidia are delicately granular, rough, or spinulose in particular rows or cultures and not in others. There is some reason to think that these cases of conidia occasionally granular are due to the presence of this old wall which takes that form under such conditions and not under others. It has not been possible to define these conditions or prove the suggestion thus far.

Shape and Measurements of Conidia

Much weight has been frequently given to shape and measurement of conidia. Westling has based his key to species upon data of this kind. Examination of his descriptions shows that he has seen the great variation of both factors even in cultures upon prune-gelatine. When successive cultures upon media of decidedly different composition are compared the contrasts become greater still. Even upon a single medium the difficulty of determining which of the sizes and shapes shall be taken as typical is noted by Westling himself, and fully appreciated by the writer with Westling's own cultures and his paper in hand for verification upon prune-gelatine. As noted by Westling in his descriptions of species certain forms give very uniform data while others are variable. Among these variable forms, the conidia may be nearly all definitely elliptical in one culture and predominantly globose upon the next culture in another substratum but grown from these elliptical spores.

Metulae

Westling has measured and described carefully the branches bearing the conidiiferous cells or sterigmata. To these he gives the new name metulae. In certain species the new term is found significant and useful. In others, attempts to place value upon the study of these branches as metulae have proved difficult. A considerable number of the forms studied show present in this position branches of very unequal length. Occasionally the same verticil would contain sterigmata, metulae and a main central branch bearing another verticil of metulae above; the metulae would thus be

formed in primary, secondary or tertiary branching groups or verticils in the same fruit mass. In other species it would be necessary to record metulae as absent so that the conidia-bearing verticils would be produced directly upon the apices of the conidiophore and its branches. This latter conception can be readily applied in a few species. Descriptions and figuring of branching systems as typical for species involves many difficulties as is recently noted by Wehmer.[5] In the same culture, corresponding septa of different conidial masses may show, single, opposite, or verticillate branching, with a change of nutrient the variation may be carried in one direction or another. Literal following of the keys furnished for generic discrimination might place different fruits of the same colony in several genera.

UNITED STATES DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

[5] Wehmer, C. Mycologisches Centralblatt, Bd. II (1913), heft 4, p. 197.

NEWS AND NOTES

Dr. Mel T. Cook delivered an illustrated lecture at the New York Botanical Garden, June 13, on diseases of potatoes.

Professor H. C. Beardslee, of Asheville, North Carolina, visited the Garden July 1 on his way to Lake Placid in the Adirondacks.

Professor L. H. Pennington spent several days at the Garden early in July, continuing his work upon the genus *Marasmius* for North American Flora.

Professor T. H. Macbride, for many years professor of botany in the State University of Iowa and for some time past acting president, has recently been appointed president of the university.

Mr. W. H. Long, forest pathologist for the United States Department of Agriculture, recently spent several days at the New York Botanical Garden, studying certain fungi of forest trees collected in Florida and North Carolina.

Dr. Fred J. Seaver spent the early part of July at Portland, Connecticut, where he was engaged in the collection and study of local fungi, especially the fleshy Discomycetes.

Miss Florence McCormick, assistant professor of agricultural botany in the Agricultural Experiment Station of Nebraska, is spending part of the summer at the New York Botanical Garden, engaged in a study of the cytology of the Mucorales.

The American Journal of Botany for March contains the address of the retiring president of the Botanical Society of America on Problems and Progress of Plant Pathology. The same number also contains an article by Alban Stewart on Some Observations on the Anatomy and Other Features of the Black Knot; also an article by Professor R. A. Harper on Cleavage in *Didymium melanospermum* (Pers.) Macbr. The entire number shows a mycological trend. The April number contains a lengthy article by Bascombe Britt Higgins on Contribution to the Life History and Physiology of *Cylindrosporium* on Stone Fruits.

The Botanical Gazette for April contains a note by Dr. Roland Thaxter on the ascosporic condition of the genus *Aschersonia* Montagne. It had been suspected that the ascosporic form, if such existed, would place this genus among the Hypocreaceae, possibly with the genus *Hypocrella*. After careful search for the ascosporic form of *Aschersonia* in the island of Grenada, the search was finally rewarded by finding a few which showed suspicious looking pustules which proved to be perithecia. In Trinidad, species of *Aschersonia* were more numerous and often showed the ascosporic stage. A study of these plants shows *Aschersonia* to be closely related to the genus *Cordyceps*. The article contains a description and illustration of the perfect stage of *Aschersonia turbinata* Berk.

ORIGIN OF THE VOLVA APERTURE IN CRYPTOPORUS VOLVATUS (PECK) HUBBARD

This interesting species of the Polyporaceae is quite common on fire-killed specimens of *Pinus rigida* west of Albany. It is one of the earliest species of that family to mature. Mature specimens were found at intervals between May 10 and June 1. The young specimens are nearly globose and sometimes slightly varnished upon the upper surface, so that at first glance they might easily be taken for the button stage of *Fomes ungulatus*. A cross section of this stage, however, shows that the hymenium is nearly if not quite mature and the absence of any opening in the thick,

hard volva naturally gives rise to the question of how that aperture which is seen in mature specimens originates.

About the time the spores are mature, a round hole is bored in the crust-like volva by small weevils (*Plesiocis* sp.), which invade the interior cavity of the fungus in great numbers and seemingly feed upon the spores. At least, they become covered with them and also invade the borings through the bark of the pines made by emerging adult bark-beetles (*Tomicus*), through which the sporophores of the fungus usually emerge. The weevil is hence an important agent in the dissemination of the spores and is responsible for the round apertures in the volva of mature specimens of *Cryptoporus*.

Another beetle, one of the short-winged scavenger beetles (*Placusa despecta* Er.) frequently takes refuge within the volva after the initial opening has been made by the weevil and may also be instrumental in the dissemination of the spores.

I am indebted to Mr. D. B. Young of the New York State Museum for the insect determinations.

H. D. HOUSE.

INDEX TO AMERICAN MYCOLOGICAL LITERATURE

Baker, C. F. The lower fungi of the Philippine Islands. A bibliographic list chronologically arranged, and with localities and hosts. Leaflets Philip. Bot. **6**: 2065–2190. 14 Ja 1914.

Bolley, H. L. Wheat: Soil troubles and seed deterioration. Causes of soil sickness in wheat lands. Possible methods of control. Cropping methods with wheat. N. Dakota Agr. Exp. Sta. Bull. 107: 9–94. *f. 1–45.* D 1913.

Caesar, L. Peach diseases. Ontario Dept. Agr. Bull. 201: 33–59. *f. 1–20.* My 1912.

Cook, M. T., & Martin, G. W. Potato diseases in New Jersey. New Jersey Agr. Exp. Sta. Circ. 33: 3–24. *f. 1–14.* [1914.]

Currie, J. N. Flavor of Roquefort cheese. Jour. Agr. Research **2**: 1–14. 15 Ap 1914.

Includes notes on cultural studies of *Penicillium roqueforti.*

Davis, S. Some fleshy fungi of Stow, Massachusetts,—II. Rhodora **16**: 45–52. Mr 1914.

Dodge, B. O. The morphological relationships of the *Florideae* and the *Ascomycetes.* Bull. Torrey Club **41**: 157–202. *f. 1–13.* 22 Ap 1914.

Fawcett, H. S. The potato wart disease. Calif. Monthly Bull. State Comm. Hort. **1**: 733–736. *f. 220, 221.* S. 1912.

A fungous disease caused by *Chrysophlyctis endobiotica* Schilb.

Floyd, B. F., & Stevens, H. E. Melanose and stem-end rot (*Phomopsis citri* Fawcett). Univ. Florida Agr. Exp. Sta. Bull. 111: 3–16. *f. 1–9.* D 1912.

Harper, R. A. Cleavage in *Didymium melanospermum* (Pers.) Macbr. Am. Jour. Bot. **1**: 127–144. *pl. 11, 12.* Mr 1914.

Heald, F. D., & Gardner, M. W. Longevity of pycnospores of the chestnut-blight fungus in soil. Jour. Agr. Research **2**: 67–75. 15 Ap 1914.

Hewitt, J. L., & Truax, H. H. An unknown apple tree disease. Arkansas Agr. Exp. Sta. Bull. **112**: 481–491. *f. 1–14.* 1912.

Howe, R. H. North American species of the genus *Ramalina.* Part I. Bryologist **16**: 65–74. *pl. 5–7 f. 1–3* S 1913; Part II. Bryologist **16**: 81–88, *pl. 8, 9.* N 1913; Part III. Bryologist **17**: *1–7. pl. 1, 2 f. 1, 2.* F 1914; Part IV. Bryologist **17**: *17–27. pl. 5, 6 f. 1–6.* Mr 1914.

Johnson, E. C. A study of some imperfect fungi isolated from wheat, oat, and barley plants. Jour. Agr. Research **1**: 475–490. *pl. 62, 63.* 25 Mr 1914.

Jones, L. R. Problems and progress in plant pathology. Am. Jour. Bot. **1**: 97–111. Mr 1914.

McDougall, W. B. On the mycorhizas of forest trees. Am. Jour. Bot. **1**: 51–74. *pl. 4–7 + f. 1.* F 1914.

Melhus, I. E. Powdery scab (*Spongospora subterranea*) of potatoes. U. S. Dept. Agr. Bull. 82: 1–16. *pl. 1–3.* 6 Ap 1914.

Morse, W. J. Spraying experiments and studies on certain apple diseases in 1913. Maine Agr. Exp. Sta. Bull. 223: 1–24. *f. 1–4.* Ja 1914.

Orton, W. A. The potato quarantine and the American potato industry. U. S. Dept. Agr. Bull. 81: 1–20. *f. 1.* 31 Mr 1914.
Contains notes on potato diseases.

O'Gara, P. J. A rust—new on apples, pears and other pome fruits. Science II. **39**: 620, 621. 24 Ap 1914.

Overholts, L. O. The *Polyporaceae* of Ohio. Ann. Missouri Bot. Gard. **1**: 81–155. Mr 1914.

Reed, G. M. The smuts of cereals. Missouri State Board Agr. Bull. 10^7: 3–15. Jl 1912.

Roberts, J. W. Experiments with apple leaf-spot fungi. Jour. Agr. Research **2**: 57–66. *pl. 7.* 15 Ap 1914.

Sewell, M. C. Soil bacteria. Ohio Nat. **14**: 273–278. 23 Mr 1914.

Stakman, E. C. A study in cereal rusts. Physiological races. Part I. Biologic forms. Minnesota Agr. Exp. Sta. Bull. 138: 5–56. *pl. 1–9.* F 1914.